VOL. 177 No. 2 AUGUST, 1952

# AMERICAN Gas Journal

SEP 15 1952 B 376260

See 28

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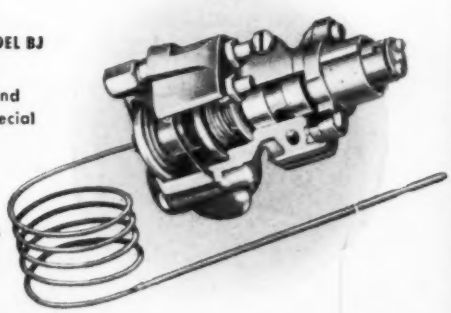

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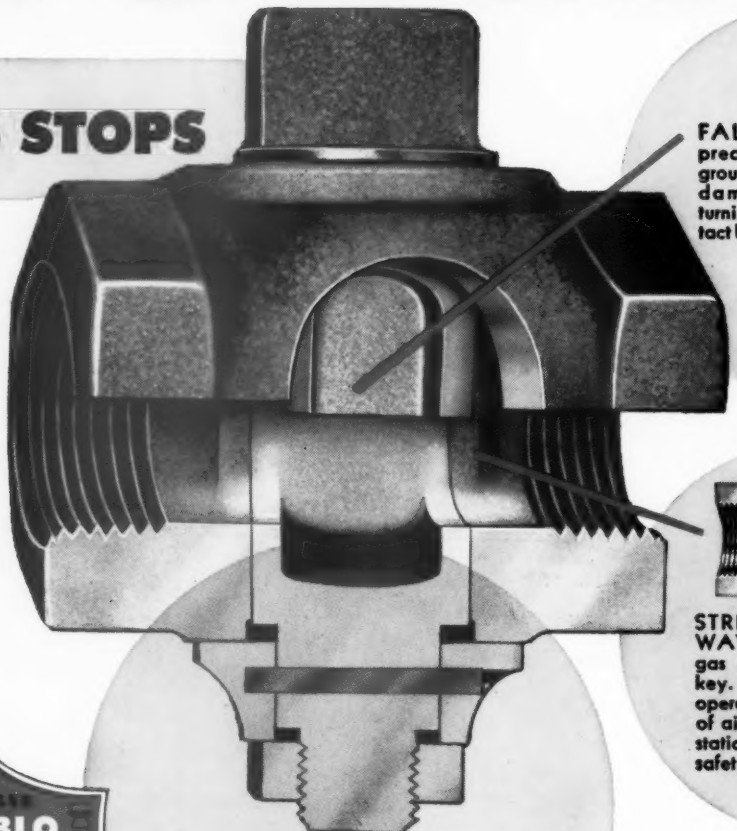

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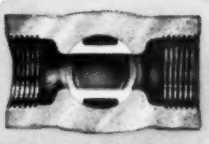

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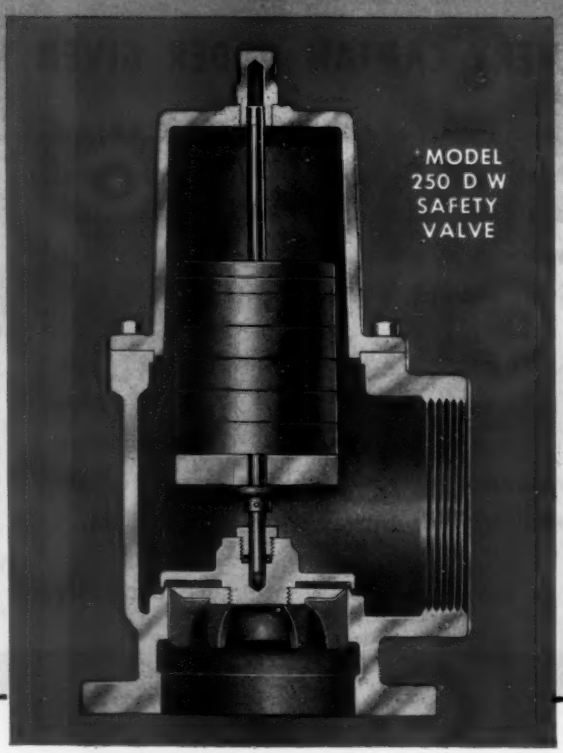

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AMERICAN Gas Journal
ESTABLISHED 1859

VOLUME 177 AUGUST 1952 NUMBER 2

## This month...

This month's chapter in the *American Gas Fundamentals* series, Principles of Absorption Refrigeration (page 23), is highly recommended reading not only for the newcomers and juniors in the industry, but for old-timers as well. Our intimate domestic indentification with the gas refrigerator dates back to one of the early water-cooled models that we installed in 1929; but we never could explain to the satisfaction of our alert and inquiring family what made the thing work. Now, armed with Dr. Berry's lucid delineation, we should be able to answer any and all questions, albeit a little late for the reestablishment of our household reputation as a gas technologist.

• • •

Still on the subject of Fundamentals: It will be noted that the outline (page 22) has been revised and several new chapters added. We welcome suggestions for additions to the course; most of the new subjects to be covered have been selected as a result of such suggestions. We should explain the time lag between the receipt of recommendations for new chapters from our readers, and the appearance in the outline of those found acceptable. Before a chapter is added to the series we select a recognized authority to author it and get his commitment to the assignment. The secret of *Fundamentals*' success is a variety of authors, each writing as an expert in his own particular field.

• • •

Our decision to be represented at the GAMA exhibit during the AGA convention at Atlantic City represents a submission to tradition that we, at once, recognize and deplore. We are convinced that this gaudy and convivial carnival drains off more good promotion funds from the gas appliance and equipment industry than it ever returns in the form of advertising or sales. Yet we will be there, along with hundreds of other exhibitors, animated only by the negative realization that it would be too conspicuous to be absent.

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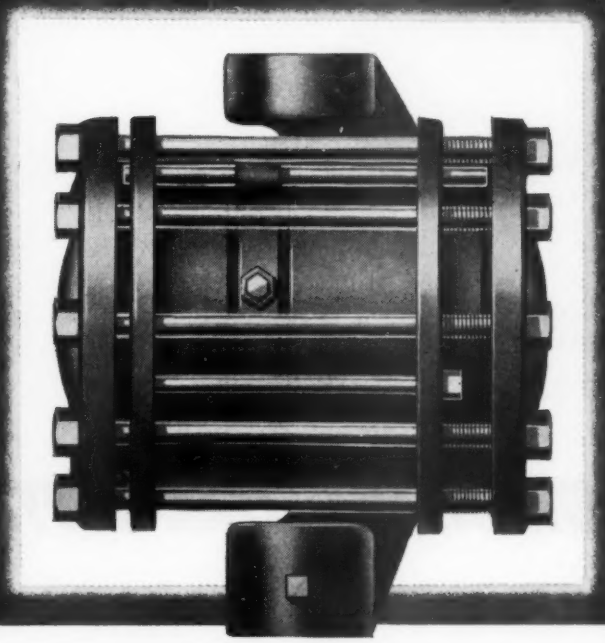

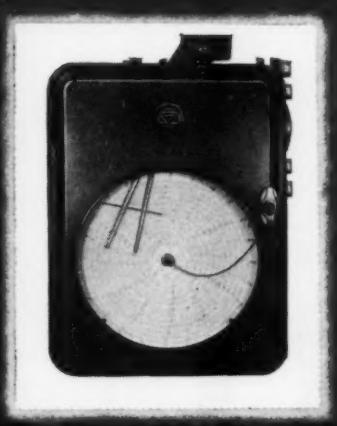

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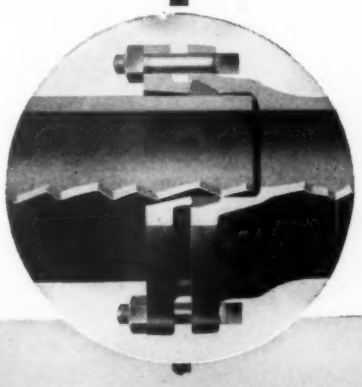

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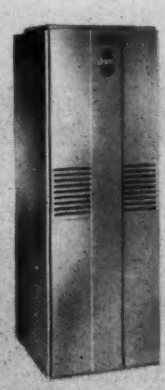

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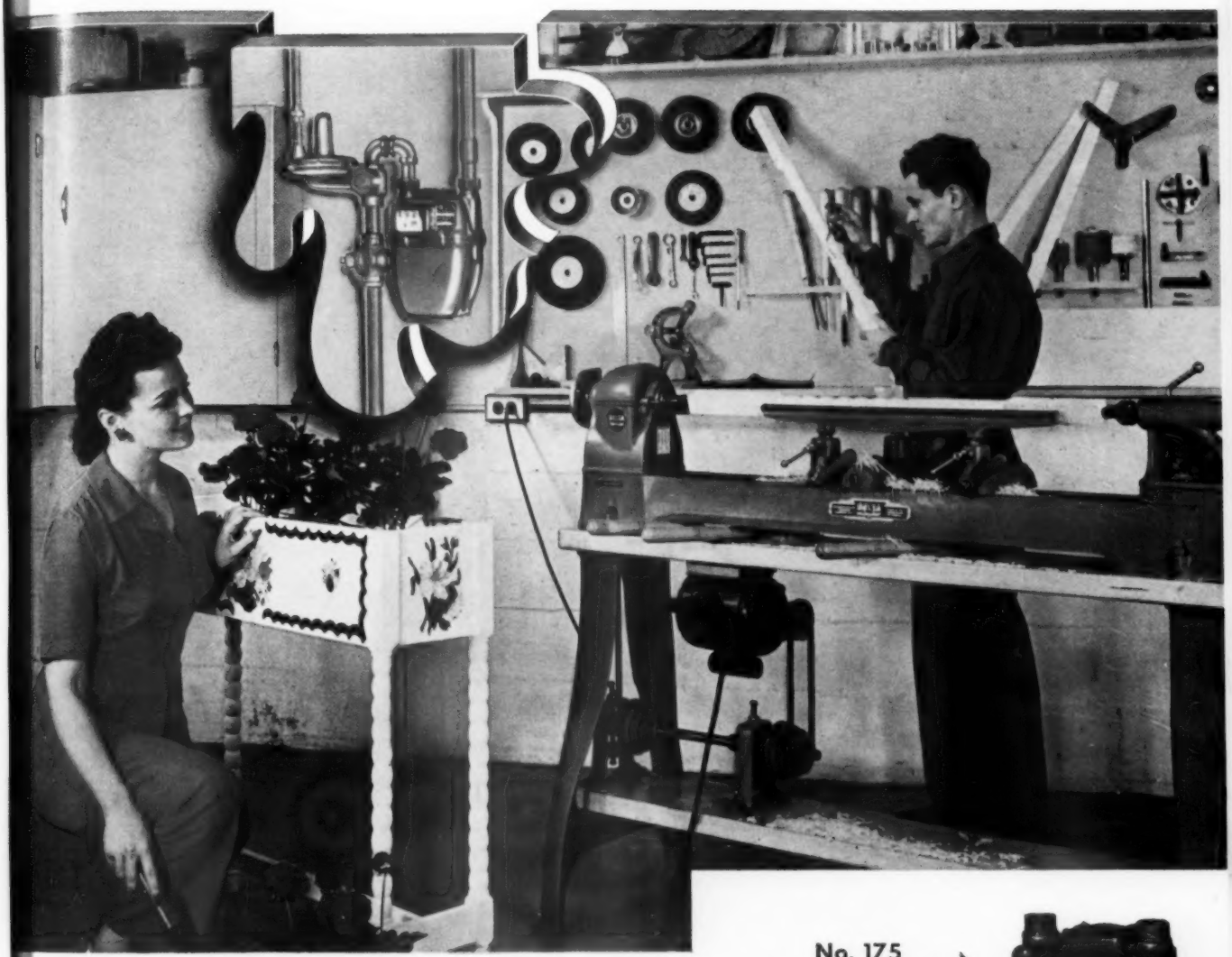

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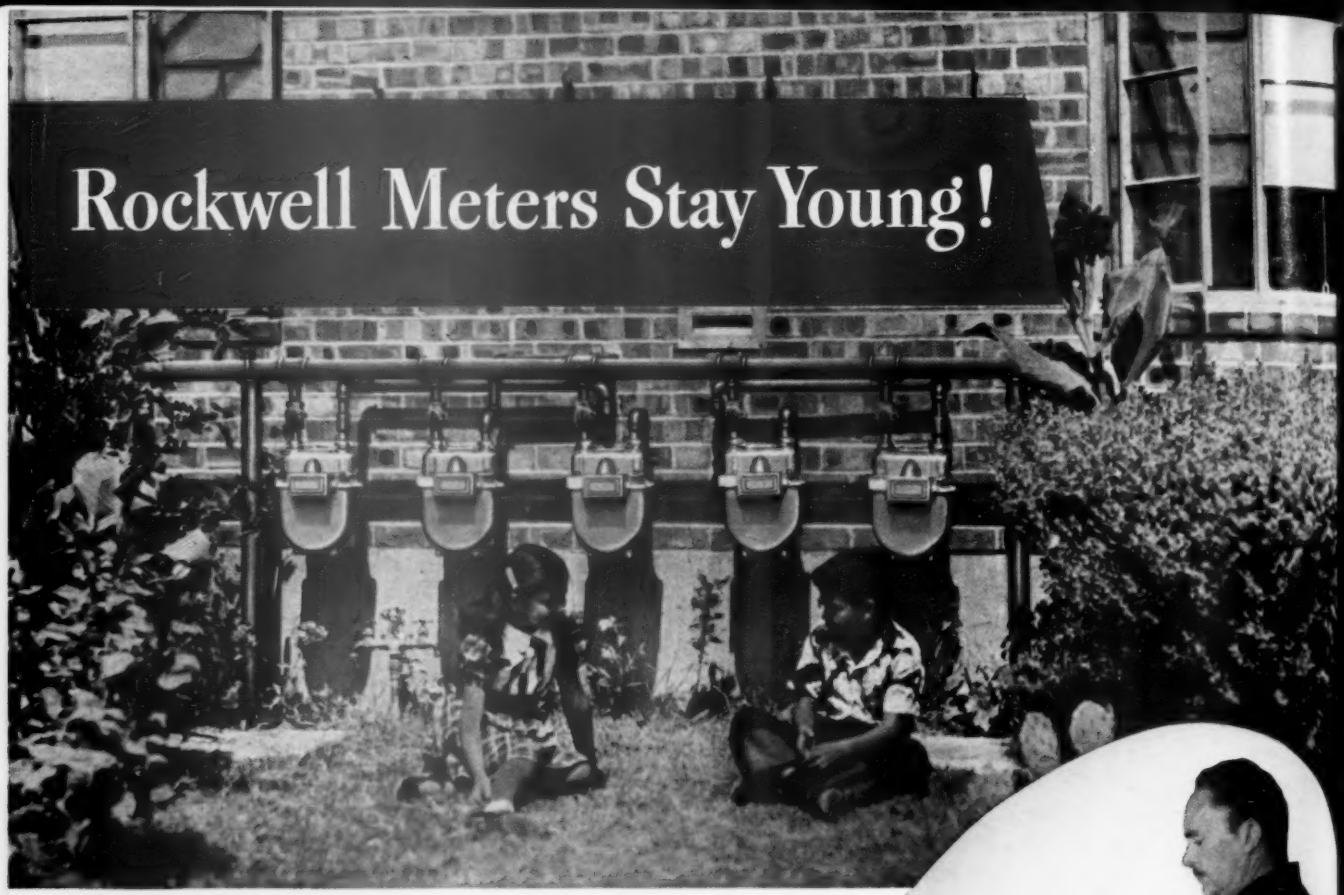

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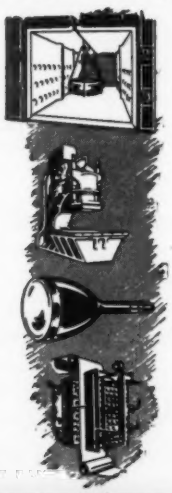

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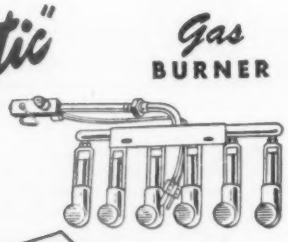

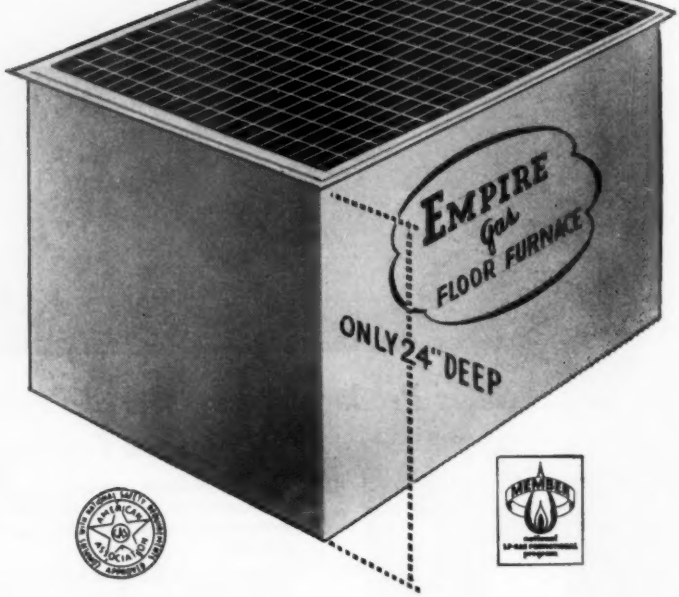


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# Editorial:

## Memo to a Fat Mahatma

WELL, TAYLOR, you know before you even start writing that nobody reads an August Editorial anyhow; so why don't you just slip off to some shady spot and curl up with a good book, or go down to Culkins Bar and Grill and watch television; or better yet get your personal affairs untangled so your estate won't be in a godawful mess when the heat and humidity get to you, as it seems to be picking off quite a few old juveniles your age this summer.

Man and boy, you have been beating your breast about the gas business for twenty-seven years, and giving them what-for in editorials for I guess fifteen, although it seems like a hundred; and what has it got you or the gas industry or the general public that you always seem to be dragging into the discussion for some reason?

The gas industry is doing just dandy Buster; but it could stand a little less criticism from an outside observer like yourself who, if he was so smart, would have had himself a little piece of Texas Eastern or Transcontinental or Tennessee Gas Transmission instead of telling them how to run their public relations in New England, or asking them to spend money to help the distributing utilities hold the cooking load which you seem to be about the only one in or out of the trade thinks they want to hold.

The trouble with you,—and mind this is for your own good like those so called challenging editorials that you write,—is that you have gone to too many gas conventions and kept on listening to what the speakers say on the platform instead of watching to see what they do when they get back home. Then somebody pats you on the head and says: You have a nice little magazine there, what do you call it, and is it a girl or a boy? And you think: Here is a great leader of the industry.

Why is it, anyway, that when you roll a sheet of white paper into a typewriter you always seem to think that you have to rewrite the magna carta or modernize the ten commandments or something. Can't you just cool down to a rolling boil for once, at least during the month of August? Couldn't you get out a little piece congratulating the industry on the great forward strides it has taken? Point out that there are now more miles of natural gas pipelines than there are feet of elevated railway track; that natural gas for househeating has knocked the props from under soft coal whenever the prices are right, or that fewer people are killed by carbon monoxide than are electrocuted in bath tubs on a ten year average? Look how rich and influential the big associations have grown, using that technique. Or can't you read anything except what you write yourself?

Someday, Son, you are going to put your big foot right in it. It's a wonder Con Edison didn't smack you down when you came out with not one but three editorials on service responsibility, and made them the goat. Before you were through you had dragged AGA and all the gas utilities into the hassel. Vice presidents had to waste time at executive conferences,—to which you were not invited I notice,—explaining that you had painted a distorted picture; and the gas association had to appoint itself a committee to report on the problem.

And when it comes to telling other people how to spend their money! Brother that's where you really take off into the plane of the flying saucers. GAMA needed a public relations campaign, to hear you tell it. So they got one and what happened? Almost a quarter of a million bucks laid on the line and now nearly everyone who looks at the package figured it must have been misaddressed. It wasn't what they ordered. And the two big groups in the industry, the gas companies and the gas appliance manufacturers, are both trying to nod the tab over to the other guy for next year's effort. They were doing that when you first eased yourself into the act in the middle twenties, so that shows the leadership that can be exerted by a keen editorial mind.

And another thing, while I am helping you out in this job of soul searching that you recommend so highly to your readers. What is all of this hullabaloo over merchandising, that seems to be your latest big mission? There you go aping the convention orators again, like a high school ingenue reading for a part in summer stock. How naive can you get? What percentage of all the readers of all the gas magazines are sales managers and the like? Seven per cent? And how much of your advertising support comes from appliance manufacturers? Never mind telling me, I can count. It will only take a minute.

That's about all I had in mind, Junior, at this time. I take it that you have enough sense not to go tearing out after the combination gas and electric utilities, like you sometimes threaten to do, claiming that they are putting all of their energy into promoting the electrical side of the business and letting gas go out and pick scratch with the chickens.

So if I don't read your obituary before then, I will probably see you at the AGA convention in Atlantic City sitting in a little booth, upholding your repeated contention that convention exhibits are a waste of time and money that only guys with the strength of their convictions have the guts to stay away from.

As a great sculptor of public opinion, Taylor, it looks as if your enduring monument turns out to be something molded in jello. With a great big fish on top.

Elliott Taylor

# Properties of Natural Gas Odorants

by Charles R. Cable*
P. A. Turcotte†
Frank H. Dotterweich‡

THE program undertaken to study the properties of natural gas odorants and how they may be more effectively used as a warning agent in the natural gas industry has been carried out in three phases at the Texas College of Arts and Industries, Kingsville, Texas.

The first phase of the work was an evaluation of the odor characteristics of commercial odorants, including a study of their chemical and physical properties. The second and third phases, laboratory and pilot plant respectively, were directed toward the sorptive properties of natural gas odorants when passing through various soils.

By means of room tests (1) some twenty-six odorants were tested. In more than 100 tests, reactions from more than 200 people were obtained. From this work with the two types of odorants, concentrated and dilute, effective odorization seems to require one-half pound of concentrated odorant and five pounds of dilute odorant per million cubic feet of gas, under average operating conditions, when the more common odorants were being used.

The average results of the tests conducted on concentrated and dilute odorants to date are indicated in figure 1.

A study of the physical and chemical properties revealed that the commercial odorants, stored as liquids to be vaporized and carried throughout a system, must have boiling points falling within certain limits. This property suggests that if odorants are removed while passing through soil and other media their sorption characteristics should not show any appreciable difference. However, soils having different surface or colloidal content should have varying sorptive capacities.

The second phase of the study(2) was carried out in the laboratory to observe certain general fundamentals relating to the sorptive properties of various soils for odorized gas.

Various soils were placed in a vertical three inch pipe, 36 inches long, and tests were conducted to observe the sorptive capacity of the soils under varying rates of flow for natural gas containing one-half pound of concentrated odorant per million cubic feet of gas. To study the relation of sorptive capacity to surface content of the soil, the surface content of the soils was gauged by means of dye adsorption (3). The results of these tests on four samples, weathered limestone, cinders, caliche and sand, are noted in table 1 and shown graphically in figure 2. These data are shown graphically in figure 3, using a semi-log plot, indicating the sorptive properties of rates of flow for two, four and six cubic feet of gas per hour when plotted versus surface content of the soil as determined by dye adsorption. The cinders sample did not exhibit fundamental adsorptive properties as did the other samples.

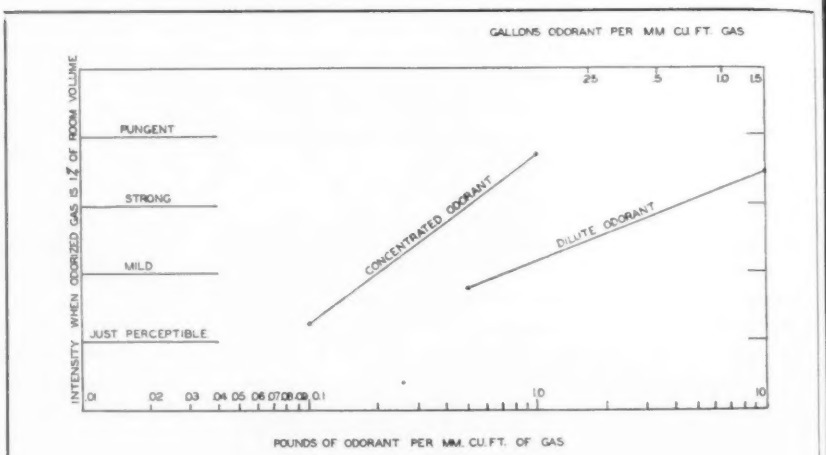


Figure 1. Odor intensity

It appeared, from the tests, that adsorption was playing a major role in removing the odorant from natural gas. Large scale pilot plant tests, more representative of actual conditions experienced in field operations, were devised and conducted.

The third and final phase of this work was a pilot plant study of the sorptive properties of various soils (4). In this study, a vertical ten inch pipe, twelve feet long, was filled with the sample to be tested. The samples were the

TABLE 1

ODORANT GAS SORPTION DATA

| SAMPLE | Weight (lbs.) | Gas (cu.ft.) | Time (hrs.) | Gas, cu.ft./ sample lb. | Gas, cu.ft./hr. | Dye adsorbed per sample gr. (milligrams) |
|---|---|---|---|---|---|---|
| Weathered limestone | 14.2 | 60.4 | 25.0 | 4.32 | 2.27 | 246 |
| | 14.0 | 58.9 | 13.0 | 4.21 | 4.53 | 246 |
| | 14.1 | 56.2 | 6.0 | 3.98 | 9.37 | 246 |
| Cinders | 14.1 | 78.1 | 17.0 | 5.53 | 4.58 | 184 |
| | 13.8 | 73.7 | 12.5 | 5.34 | 5.9 | 184 |
| | 13.5 | 68.3 | 8.75 | 5.06 | 7.8 | 184 |
| | 13.4 | 62.5 | 6.25 | 4.67 | 10.0 | 184 |
| Caliche | 16.9 | 29.6 | 15.0 | 1.75 | 1.97 | 105 |
| | 16.8 | 21.9 | 5.5 | 1.31 | 3.99 | 105 |
| | 16.5 | 12.2 | 2.0 | .74 | 6.1 | 105 |
| Sand | 19.0 | 21.6 | 8.33 | 1.14 | 2.59 | 24 |
| | 21.0 | 19.1 | 5.25 | .91 | 3.65 | 24 |
| | 21.2 | 16.1 | 3.0 | .76 | 5.37 | 24 |

* Freeport Sulfur Company, Freeport, Texas.
† The Ohio Oil Company, Henderson, Texas.
‡ Texas College of Arts and Industries, Kingsville, Texas.

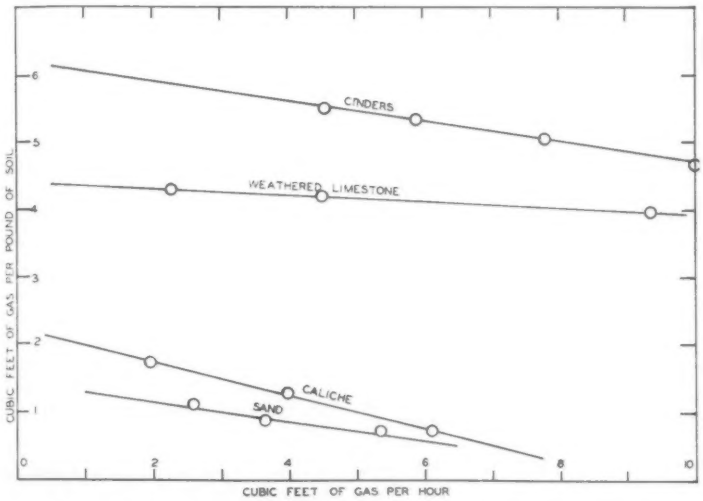


Figure 2. Rate of flow vs. cubic feet of gas per pound of soil

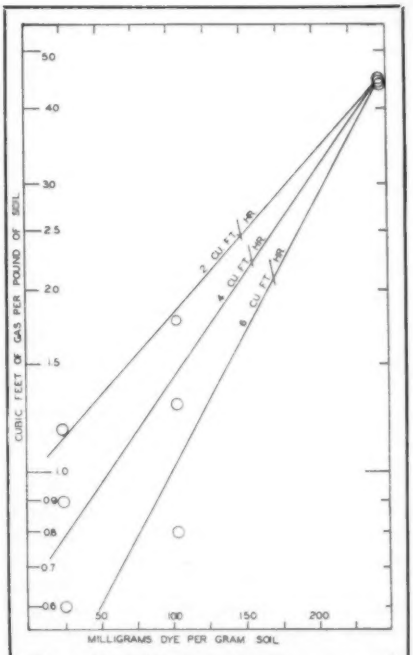


Figure 3. Cubic feet of gas per pound of soil vs. mgms of dye per gram of soil

same as used in the second phase of the work. In addition, black soil was tested. The results of these tests are reported in table 2 and presented graphically on a straight plot in figure 4. These data appear to confirm the laboratory studies in that adsorption is primarily the method by which the odorant is removed, with the exception of the cinder sample.

The sorptive properties noted may possibly be explained as follows: Most commercial odorants are sulfur compounds of one kind or the other with odor strengths in ascending order, that is: disulphides, thioethers, cyclic compounds and mercaptans. The mercaptans in various combinations are more widely used, and their odor strength in ascending order is methyl, ethyl, butyl, propyl and isoamyl mercaptan. Thus, for a given odor concentration, smaller amounts of the heavier mercaptans would be required.

It should be noted that the ability of a soil to adsorb increases with the molecular weight of the compound.

It has been reported (5) that a gas odorized with a mercaptan odorant, in leaking from a pipe line and passing through soil, may have its odor intensity reduced by these three possible actions:

(a) physical adsorption of the mercaptan by the soil; (b) chemical absorption of the mercaptan by the soil constituents; (c) oxidation of the mercaptan to a disulfide in the presence of soil constituents.

In this report, J. S. Powell noted that mercaptans are oxidized in the presence of iron oxide to disulphides. Thus, in the case of the cinder sample, it may be concluded that since the gas was odorized with an odorant chiefly composed of mercaptans that these compounds were oxidized to the less odoriferous and more adsorbable disulphide, thereby accounting for the different properties exhibited by this sample.

By similar reasoning, it appears that the removal of the odorant while passing through weathered limestone, caliche, sand and black soil was primarily by adsorption.

These sorptive properties of soils for commercial odorants create a hazard when odorized natural gas leaks from the system and passes through soil before entering an enclosed area. The amount of deordorized gas which will enter the room before it is detectible will depend upon the type of odorized gas and the amount and type of soil it passes through. Figure 5 has been constructed for natural gas containing one-half pound of a concentrated odorant passing through various soils and entering an air-tight room in which the lower explosive limit is assumed to be five per cent by volume gas.

The formula for such a system was developed as follows: The equation for the line plotted in figure 4 is $y = 5w_d + 0.69$, where "y" equals volume in cubic feet per pound of soil, and "w" equals weight of malachite green adsorbed in grams per gram of soil.

By multiplying both sides by the weight of the soil, a formula is obtained for the volume of gas in cubic feet that must pass through "W" pounds of soil before it could be detected: $Q = (5w_d + 0.69)W$.

Room tests using natural gas with .5 pound of odorant per million cubic feet indicated that an odorized gas concentration of .047 per cent must be obtained in a room of volume "V" before it can be detected.

Adding this factor to the above equation obtains this formula for the volume of gas escaping through soil into a room before an odor can be detected: $Q = (5w_d + 0.69)W + 0.00047V$.

These formulae show that the odor lost by the natural gas varies directly with the amount and colloid content of the soil incurred while escaping. Assuming the lower explosive limit of natural gas to be five per cent, a relationship between the volume of the

*(Continued on page 34)*

TABLE 2

ADSORPTION DATA

For gas flow rates of from five to ten cubic feet per hour

| SAMPLE | Dye adsorbed per sample gr. (grams) | Gas (cu.ft.) | Soil (lbs.) | Gas, cu.ft./soil lb. |
|---|---|---|---|---|
| Weathered limestone | 0.246 | 900 | 471 | 1.91 |
| Cinders | 0.184 | 1300 | 400 | 3.25 |
| Caliche | 0.105 | 510 | 453 | 1.13 |
| Sand | 0.024 | 510 | 580 | 0.88 |
| Black soil | 0.519 | — | — | 3.40 |

# Personnel Training for LP Gas Plants

by S. C. Symnoski
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*Adapted from a presentation to American Gas Association Production and Chemical Conference*

THE advent of liquid petroleum gas in the gas making processes of The Philadelphia Gas Works Co. brought us to face a new field in which our management recognized a real need of fully training our supervisory and operating personnel to give assurance of the safe and orderly operation of the LP plant.

In all the operations related to the use of liquefied petroleum in the gas plant, whether it be daily or standby use, peak shaving or other uses, operating personnel are required. The need of trained men for these operations is recognized by the industry and regulatory bodies as noted by frequent reference to *properly trained personnel.*

There are presently no recommendations on what constitutes well trained operators, how they could best be trained, and of equal importance, maintained in a state of alertness and "know-how."

Widely-spaced, intermittent operation makes it necessary to have a policy on refresher training, more so than when operations are much more frequent or to a degree constant.

Our training program, to a great extent exploratory and by no means complete, is presently serving us well in maintaining our operating personnel conditioned to safe LP operations.

## Equipment at PGW's LP gas plant

The installation at station "A" consists of eighteen tanks, each having a 30,000 gallon displacement, with conventional accessories and trim. Eight additional tanks are to be installed, making available a total storage capacity at the plant of approximately 650,000 gallons. A similar installation of twenty storage tanks and auxiliary equipment is in process of construction at Station "B."

## LP gas uses

The present use of LP gas in our process is reserved for standby in event of a natural gas failure or a serious curtailment, and for peak shaving. At certain load levels it is imperative that the LP equipment can be gotten on the line from a shut-down condition within one hour.

To accomplish this with safety it is necessary that all of the operating personnel are well trained and maintained in a state of readiness.

## Manning of LP plant

The LP installation is manned around the clock with one operator. When the plant is in a shut-down status, he serves as a security and fire watch. He observes and makes record of liquid temperatures, pressures and liquid levels. He patrols the farm and vaporizer area, alerted for fire hazards, infringement of safety regulations, and illegal entrances to the area. He makes record of all personnel entering and leaving the restricted area, other than posted operating personnel.

On a scheduled routine he checks manheads on tanks, valves, flanges, stuffing glands, relief valves, etc. for leaks, using a portable explosimeter. He is responsible for housekeeping in the farm area, vaporizer room, and control area. He has full authority to halt any work or activity when, in his judgment, such work or activity constitutes a hazard. Such stop orders are binding on all personnel. He assists in the unloading of LP to storage under the direction of a supervisor.

When the plant is in operation, the area attendant operates at the farm only, tending the liquid pumps and lines, shifting tanks, and maintaining operating records.

A second operator is used in conjunction with the operation of the vaporizers, modified LP and cold enriching, changing rates to accommodate load and interchangeability requirements. Both operators are equally trained in both phases and are regularly interchanged as a means of "on the job" training.

## LP training supervisor

In their consideration of the problems inherent in LP operations, management decided that the study of LP usage, safety policies, and the initial training of operating personnel would require the full time of a technically trained supervisor, well in advance of the completion of the LP gas plant. A shift supervisor with substantial gas plant operating background was relieved of his duties and assigned to this work exclusively.

His investigation was to cover LP gas plant operation in all its phases, including operating procedures of others in the industry.

Arrangements were made with many gas companies in the New York and New Jersey areas for visits to plants where LP gas was in general use. We drew freely from this information to develop our own operating procedures and practices.

In a relatively short time he was able to competently advise plant management on the training methods to adopt, safe practices and operating procedures best suited for our local conditions and needs.

On final completion of the LP system, the training supervisor was active in the purging operations prior to loading the farm. He directly supervised the unloading to storage of all the tank trucks and tank cars required to fully load the farm. During the period of the initial loading, a training schedule was designed whereby those shift supervisors who would be involved in the operation of the LP plant were trained in the proper unloading procedure under the direction of the training supervisor. A few selected supervisors now direct the unloading of LP to storage.

## Training shift supervisors

Concurrent with the development of the training supervisor, other shift supervisors were first oriented to liquefied petroleum by making available to them literature on LP plant design, description of all auxiliary equipment, the chemistry and characteristics of liquefied petroleum gases and established operating techniques of other plants.

As the training of the supervisory group progressed, many differences of opinion were voiced on operating technique. It was soon recognized that standard operating procedures had to be developed, but it was unanimously agreed that actual LP operations had to be experienced many times before hard and fast operating instructions could be released. The next step in our training program was the development of the LP operating manual.

## LP operating manual

With the completion of the LP plant, ample opportunity was given to the supervisory group under the direction of the training supervisor to make many practice and actual runs. Procedures for the operation of the tank farm equipment, vaporizers, and controls were written and submitted to the group for study and constructive criticism.

Safety orders and practices were developed, discussed at plant safety meetings, and finally written for inclusion in the manual with many simple but effective drawings.

Following is the table of contents of the manual in its present form.

I. GENERAL.
- A. General information concerning LP gases.
- B. General description of the Station "A" installation.
  - Tank farm.
  - Unloading system.
  - Liquid-transfer pumps and lines.
  - Vaporizers.
  - LP-air installation (modified LP).
  - LP cold enrichment installation.
- C. Specifications of major equipment and instruments.

II. RECEIPT AND UNLOADING PROCEDURE.
- A. Description of the unloading facilities.
- B. Unloading procedure.
  - Tank car.
  - Tank truck.

III. Operation of Tank Farm.
- A. Routine care.
- B. Procedure for using the LP (starting and shutting down).
  With transfer pump.
  Without transfer pump.
- C. Use of liquid line to vaporizers.

IV. Operation of Vaporizers.
- A. Description of controls and methods of control.
- B. Procedure for starting vaporizers.
- C. Procedure for shutting vaporizers down.

V. Operation of Cold Enrichment Facilities.
- A. Description of controls and methods of control.
- B. Procedure for starting cold enrichment.
- C. Procedure for shutting cold enrichment off.

VI. Operation of LP-Air Equipment.
- A. Description of controls and methods of control.
- B. Procedure for starting use of LP-Air.
- C. Procedure for shutting LP-Air equipment down.

VII. Standing Orders.

VIII. Safety Orders.

IX. Selection and Proper Use of Safety Tools.

X. Fire Protection Equipment.

XI. Description of LP Fire Fighting Methods and Proper Use of Equipment.

XII. Calculations and Records Necessary to Determine LP Vapors Used.
- A. Cold enrichment.
- B. LP-Air.

All operating personnel were furnished with a manual for individual use and study. It is recognized that as more operating experience is gained, improved operating technique will be developed, and revisions and additions to the manual must follow. It is the function of the supervisor of the operating division of the plant directly responsible for LP operations to keep the manual up to date with current practices.

### Training of operators

A group of nine men were selected as trainees. Each man was a qualified gasmaker. They were divided into three groups and each group in turn was given six days of concentrated instruction on the activities involved in the operation of an LP gas plant. The instruction given at this time was principally in the form of classroom lectures, study, and discussion periods under the direction of the training supervisor.

In addition to the classroom work, a daily tour of the LP plant was made and the instructor explained the operation of integral parts of the plant, their function, and their design. Toward the end of the orientation period, each group made about eight "dry" runs of the LP equipment and finally several actual runs, all of which were closely directed by the instructor.

On completion of this training assignment, the men were scheduled to a shift as LP plant area attendants for security, safety, and fire watch service, and a new group was started in the orientation classes.

After the entire group had completed the orientation training, and all shifts were covered with two men, actual training runs were made. The LP plant was operated daily under direction of the training supervisor with LP area attendants and shift supervisors participating. Daily training runs were made for about a month after which it was considered that all operators were fully qualified to operate the LP plant equipment with a minimum of direct supervision.

With the completion of the training program to this point, the service of a full-time instructor was not necessary and he was returned to his former duties.

### Training follow-up

With the completion of the formal training program, the maintenance of the "know how" of the operating personnel became the function of the supervisor directly in charge of the LP plant activities.

A program of refresher dry runs and actual operations is in practice on a scheduled basis. The schedule presently in use gives each operator two dry runs and one actual run each week. The present schedule of actual runs for refresher training requires the use of about 10,000 gallons of LP each month.

Check-off lists are used by the operators each time the plant is activated. The use of check-off lists is strongly recommended as a means of reminding the personnel of proper and orderly procedure in placing the equipment in operation.

### Fire fighting and control school

The Philadelphia Gas Works Co. is now making ready equipment and other related facilities for the establishment of a fire fighting and fire control school. A course will be set up at the school to train our LP operators in the methods of fighting and controlling LP fires. Pending the completion of this school, the operators are drilled in the use of the fire fighting equipment and given class instruction by the plant safety and security officer.

### Conclusions

From the date the LP plant was available for use, we have used approximately 175,000 gallons of liquid petroleum for training purposes. When consideration is given to the enormous potential energy of the liquified petroleum in storage within our plant, our belief is that well trained men should be used in every function of LP operations and that the cost of the program is justified.

Lectures, manuals, and "dry" runs are extremely helpful as training mediums but are not in themselves sufficient. Actual operation of the LP equipment on a scheduled basis is the only practical way we know of that will keep the operators skilled in the safe and proper handling of LP gases.

## Gas Facilities Withstand California Quake

From the gas industry's point of view, only minor damage was wrought by the tremendous earthquake which rocked California from the Golden Gate to the Mexican border for almost a full minute shortly before 5:00 AM, July 21.

Surpassed only by the 1906 San Francisco earthquake and fire, the tremblor was of 7.5 intensity, or almost 100 times as powerful as the Long Beach quake of March, 1933, which claimed many lives, leveled buildings, and disrupted communications and utility services in many Southern California communities.

It was fortunate for the heavily populated Los Angeles basin and San Francisco Bay areas that the epicenter of the quake was situated in a little-populated section about 160 miles northeast of Los Angeles. Tehachapi, a town of 2,000 souls and home of the California Institute for Women, bore the brunt of the tremblor, with eleven deaths being recorded and property damage estimated at $2,600,000. In nearby Arvin a number of brick walls fell.

Although the 1952 quake has been estimated to have loosed the energy of 2,000 (Hiroshima) atomic bombs, it is notable that the force did no damage to Pacific Gas and Electric Company's 34-inch transmission line which runs near Tehachapi.

While Southern California Gas Company, which serves Tehachapi, maintains no office in that town, contact was made immediately with the company's office in Oildale, just outside of Bakersfield, and an emergency crew arrived at the isolated scene of the quake epicenter within three hours of the shock. Contact with the Oildale office was established by two-way radio. A service crew of nine men dispatched to the scene found it necessary to disconnect only about 40 services, since most of the frame-constructed residential buildings in the area withstood the quake virtually without damage.

Due to a break in a supply line in the San Joaquin Valley, it was necessary for the gas company to curtail service, for approximately 24 hours, to the Monolith Portland Cement plant, a large industrial user located on the outskirts of Tehachapi. By the morning of July 22, full service was restored to this plant.

In the Los Angeles area, very little damage was reported either to transmission or distribution facilities. Considering the intensity of the quake, this is a fact which speaks well for the durability of modern, steel welded pipelines and distribution systems.

As a result of aftershocks, a 6-inch feeder line to Tehachapi has been placed in a precarious position with a 75-foot section exposed by earth slides. The line is under constant surveillance and a standby arrangement has been made by Southern California Gas Company with Pacific Gas and Electric Company to tap PG and E's 34-inch line for emergency service to Tehachapi's domestic users in the event of a break in the feeder line.

—A. R.

# Origins and Character of Deposits in Natural Gas Pipelines

by L. T. Bissey
The Pennsylvania State College

*Adapted from a presentation to American Gas Association Production and Chemical Conference*

THE increasing importance of natural gas pipe line deposits prompted the Pennsylvania Natural Gas Men's Association to approve for study, at The Pennsylvania State College, the subject of "Dust in Natural Gas Pipelines."

Samples of deposits submitted by member companies were studied. Without exception, iron compounds predominated in all samples; in all but one sample, iron oxides were the major components. Mineralogical examinations found most of the iron oxides in the forms of goethite and magnetite. Several samples contained more than fifteen per cent silica, and a group of samples from a common source contained about fourteen per cent sodium chloride. The percentage of construction dirt found in the samples studied was generally small. The major source of the common pipeline deposits is the pipe itself, mill-scale being a source of magnetite and subsequent rusting furnishing other oxides.

The objectives of the continuing study are the determination of the origin of the deposits and the suggestion of preventive measures.

## Forms of iron oxide

Since the predominating compounds found in all but one sample of pipeline deposits examined by the laboratory were iron oxides, a brief review of some of these compounds is in order.

Nearly everyone who has handled a piece of iron or steel is familiar with iron oxide in the common forms of mill-scale and rust.

Mill-scale is known chemically as ferrosoferric oxide or ferrous ferrite, $Fe_3O_4$ or $Fe(FeO_2)_2$, and to the mineralogist, it is known as magnetite. This black oxide serves as a protective coating for iron as long as this particular oxide film is continuous and undamaged.

Ferric oxide, $Fe_2O_3$, varies from reddish-brown to black in color and is also known as hematite. Variation in the amount of water of crystallization found with ferric oxide yields goethite, which is monohydrated ferric oxide, $Fe_2O_3.H_2O$, a yellow, red or brown material, and limonite which is trihydrated di-ferric oxide, $2Fe_2O_3.3H_2O$, a yellowish-brown material.

## Mechanism of rusting

Iron rust seems to be an indefinite mixture which varies according to the age and environment of the rust. Analyses have shown that rust is probably a mixture of iron oxides, usually hydrated, and small amounts of basic iron carbonates.

Rusting is a complex process, and workers are by no means agreed on the mechanism involved. However, many of the hypotheses for the mechanism are related and many facts have been established. When commercial iron is exposed to humid atmosphere for a short time, it soon becomes covered with rust. Dry iron in dry air does not rust, moisture must be present before rusting can occur. Some deny, others affirm, that the presence of an acid and water are necessary. However, the evidence seems in favor of the conclusion that the presence of an acid is necessary for rusting; that an acid is always present when the iron dissolves; and it is highly probable that pure iron does not undergo appreciable oxidation when exposed to pure water and to pure oxygen.

The most logical mechanism of rusting may be briefly stated as follows: Moisture may condense on a surface of iron exposed to air. Carbon dioxide and oxygen will go into solution in the moisture; the carbon dioxide forms carbonic acid in aqueous solution. Carbonic acid then attacks the iron forming ferrous carbonates which in contact with the dissolved oxygen are oxidized to basic ferric carbonates which in turn are hydrolyzed by water to ferric hydroxide. The ferric hydroxide is subsequently more or less dehydrated forming ferric oxide. Thus we have rust.

Ferric oxide is somewhat hygroscopic, so that once rusting has started, at any point subsequent corrosion is more rapid because the ferric oxide helps to keep the surface of the iron adjacent to the rust spot moist.

The texture of rust probably plays an important role in its continued formation. Rust does not form as a compact film but rather as a bulky scaly structure which will hold moisture within the crevices or which may flake off readily when disturbed.

## Results of analyses

The analyses of thirty-one pipeline deposits have been completed; all samples have undergone chemical analysis and some of them screen and mineralogical analyses.

The first deposit sample received for analysis was the only one in which iron oxides were *not* the predominate compounds. It was a very light cream colored, finely divided powder removed from a serv-

TABLE 1

| | M-2 | M-3 | MO-2 | MO-3 | MO-5 | MO-6 | MO-7 | MO-8 | MO-9 | MO-10 | MO-11 | P-1 | P-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $H_2O$ | 1.8 | 1.7 | 3.3 | 2.8 | 1.7 | 1.6 | 3.4 | 0.8 | 3.0 | 1.3 | 0.4 | 2.8 | 3.0 |
| $Fe^\circ$ | | | | | | | | | | | 16.7 | | |
| $Fe_2O_3$ | | 41.5 | | | | | | | | | 59.4 | | |
| $Fe_2O_3.H_2O$ | 75.1 | 44.4 | 91.8 | 74.1 | 42.1 | 53.8 | 70.1 | 32.6 | 91.6 | 83.1 | | 64.9 | 63.8 |
| $2Fe_2O_3.3H_2O$ | 11.1 | | | | 19.3 | 9.5 | 20.8 | 15.6 | | | | | |
| $Fe_3O_4$ | | | | 7.4 | 25.6 | 22.2 | | 22.0 | | 3.8 | 7.8 | | |
| $SiO_2$ | 2.0 | 4.6 | 0.5 | 0.9 | 1.1 | 1.3 | 1.3 | 14.9 | 0.1 | 1.6 | 11.7 | 1.2 | 0.0 |
| $FeSO_4$ | 3.5 | 4.3 | 1.4 | 11.8 | 0.8 | 1.7 | 1.7 | 2.0 | 1.7 | 3.3 | 0.8 | 14.9 | 12.6 |
| H | 0.8 | 0.7 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.7 | 0.4 | 0.3 | 0.3 | 0.4 | 0.7 |
| C | 5.5 | 3.6 | 2.7 | 2.5 | 3.0 | 3.1 | 2.4 | 10.5 | 3.2 | 3.5 | 0.8 | 3.7 | 5.0 |
| NaCl | | | | | | | 0.1 | trace | 0.6 | 1.4 | trace | 12.5 | 13.1 |
| $CaCl_2$ | | | | | 0.1 | 0.1 | | | 0.1 | 1.4 | | 1.2 | 1.8 |
| $CaCO_3$ | | | | | 5.9 | 6.4 | 0.1 | 0.5 | | | 3.0 | | |
| $MgCl_2$ | | | | | | | | | 0.0 | 0.0 | | 1.4 | 0.7 |
| $MgCO_3$ | | | | | 0.0 | 0.0 | 0.0 | 0.0 | | | 0.0 | | |
| Total | 99.8 | 100.8 | 100.1 | 99.8 | 99.9 | 100.1 | 100.2 | 99.6 | 100.7 | 99.7 | 100.9 | 103.0 | 100.7 |
| Calc. Ign. Loss | 17.2 | 10.8 | 13.1 | 15.6 | 12.5 | 13.2 | 13.6 | 17.1 | 13.7 | 13.6 | 2.6 | 17.8 | 21.2 |
| Detr. Ign. Loss | 17.3 | 10.3 | 13.3 | 15.0 | 12.4 | 13.3 | 14.1 | 17.0 | 13.8 | 13.3 | 0.4 | 17.8 | 23.2 |

ace line and it analyzed about 99 per cent tetrahydrated ferrous sulphate.

Conventional methods of chemical analysis were used to obtain the quantity of each constituent and mineralogical analysis, X-ray in this case, was used to identify the iron compounds present. An approximation of the relative amounts of the various iron compounds was also obtained by the latter method. By a combination of these two analytical tools, it is possible to calculate a reasonably substantiated composition of the material. This has been done for the deposits shown in Table 1. Two tests apply to indicate correctness within the precision of the procedure: first, the composition must total to 100 per cent; second, the calculated ignition loss must agree with the determined ignition loss.

The analyses given in Table 1 are for deposits taken from natural gas systems, except sample MO-11, which was from a mixed gas system. Moisture was determined by drying in an oven for one hour at 105°C. Metallic iron, Fe°, was manually separated in the cases of MO-11 and W-7, during the preparation for chemical analysis. This metallic iron was mostly the result of welding; upon grinding of the sample in a hand mortar the iron simply became polished and retained its size. The low determined ignition loss reported for MO-11 and W-7 indicates that some of the metallic iron was also included in the sample for chemical analysis. The clues for the particular iron oxides which are calculated in the analyses were obtained from the X-ray analyses and an unconventional method of calculating the percentage of iron in the deposits on a moisture, $SiO_2$, S, H, C, $Cl^-$, CaO and MgO free basis. Such systems of calculations can be done readily for two iron oxides but become rather cumbersome for the inclusion of three or more iron oxides.

Silica was well below 10 per cent on most samples but considerably higher in several cases. The behavior of the material indicated that in all cases at least most of the silicon was originally present as silicon dioxide. Ferrous sulphate shown in the analyses is the result of computing all the sulphur as $FeSO_4$. Hydrogen was determined as total hydrogen and the hydrogen equivalent to all the water shown in a given sample was subsequently subtracted. Carbon was also determined as total carbon by combustion method. The source of the carbon presents somewhat of a problem; there is reason to believe that it is carried into the pipeline by the gas in the form of oily and waxy materials or other well deposits. Sodium chloride was calculated from the chloride ion determination and this salt was definitely shown to be present in some samples by mineralogical examination. The calcium and magnesium salts were calculated from the determination of calcium and magnesium as the oxides.

Pertinent information of a few specific deposits is of interest.

Deposits MO-5 and MO-6 were collected from the same location; the latter was collected about six weeks later than MO-5 according to the available information. P-1, P-2, and P-3 were collected the same day from the same steel wool-packed scrubber upstream from a regulator. P-1 was taken from the bottom compartment or inlet side of the scrubber; P-2 was taken from the top compartment or inlet side of the scrubber; and P-3 was shaken from the no. 2 steel wool packing (4 inches thick) used in the scrubber. The screen analyses of these three samples are shown in Table 2. Deposit W-7 indicated construction residue in the form of metallic iron and upon studying the source it was found that the installation was comparatively recent.

## Conclusions

Previously, it was noted that rusting was attributed to the action of water, oxygen and carbon dioxide on iron. All these necessary compounds are present in natural gas systems. It is true that on a percent-by-volume basis, oxygen, carbon dioxide and water total a very small fraction of the whole; but under the pressure in the pipeline, the weight per cubic foot of any of these compounds becomes significant.

Assuming the oxygen content of a natural gas to be 0.1 per cent by volume, then, if this gas is compressed to about 280 psig, the weight of oxygen per cubic foot of the compressed gas is equal to one-tenth the weight per cubic foot of oxygen in atmospheric air.

To assume the carbon dioxide concentration of a natural gas to be 0.1 per cent by volume is not unreasonable; this percentage is greater than the carbon dioxide concentration in fresh air at atmospheric pressure. Probably a still more important factor is the increased solubility of carbon dioxide and oxygen in water under pipeline pressure.

The mechanism of rusting indicates that the controlling factor for initiation and continuance of rusting is the presence of carbon dioxide dissolved in water. The water needed for this process need not be a continuous film on the pipe surface but can be the liquid water existing in minute crevices, fissures, imperfections and scratches in the iron surface even though the gas is not saturated with respect to water at the line conditions. Water held by the hygroscopic properties of rust as well as that held in the crevices of the rust performs in the same manner.

Since the moisture is continually in contact with carbon dioxide and oxygen, the time required for saturation of the water with these gases does not enter the picture.

*(Continued on page 48)*

**TABLE 2**

| | | *P-1* | *P-2* | *P-3* |
|---|---|---|---|---|
| | On 10 mesh | 0.22% | 0.01% | 0.05% |
| through 10 mesh; | on 20 mesh | 0.52 | 0.02 | 0.30 |
| through 20 mesh; | on 40 mesh | 7.40 | 0.04 | 1.79 |
| through 40 mesh; | on 60 mesh | 16.58 | 0.12 | 9.17 |
| through 60 mesh; | on 80 mesh | 14.11 | 1.99 | 61.61 |
| through 80 mesh; | on 100 mesh | 9.90 | 0.71 | 17.82 |
| through 100 mesh; | on 170 mesh | 25.18 | 37.58 | 7.12 |
| through 170 mesh; | on 200 mesh | 7.67 | 32.42 | 0.75 |
| through 200 mesh; | on 270 mesh | 10.68 | 20.21 | 0.56 |
| through 270 mesh; | on 325 mesh | 4.18 | 4.64 | 0.36 |
| through 325 mesh; | on pan | 3.56 | 2.26 | 0.46 |
| Total | | 100.00 | 100.00 | 99.99 |

Screen sizes given in U. S. Sieve series numbers.

**TABLE 1, continued**

| | *P-3* | *W-1* | *W-2* | *W-3* | *W-6* | *W-7* | *W-9* | *W-10* | *W-11* | *W-12* | *W-13* | *W-14* | *W-15* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $H_2O$ | 3.1 | 1.5 | 1.0 | 1.5 | 0.7 | 0.9 | 0.6 | 1.1 | 0.5 | 1.8 | 1.1 | 0.7 | 1.2 |
| $Fe^\circ$ | | | | | | 8.3 | | | | | | | |
| $Fe_2O_3$ | | 39.7 | 10.2 | | | | | | 18.1 | 29.2 | | | |
| $Fe_2O_3.H_2O$ | 63.3 | | 76.1 | 85.7 | 63.9 | 54.6 | 64.1 | 36.1 | 67.2 | 32.4 | 41.4 | 49.4 | 83.1 |
| $2Fe_2O_3.3H_2O$ | | 8.4 | | | | | | | | | 28.5 | 38.5 | |
| $Fe_3O_4$ | | | | | 7.6 | 11.9 | 17.6 | 49.0 | | | | | |
| $SiO_2$ | 1.3 | 7.7 | 2.5 | 2.0 | 17.4 | 15.4 | 9.3 | 2.9 | 3.0 | 3.6 | 20.9 | 8.1 | 8.7 |
| $FeSO_4$ | 14.0 | 27.2 | 2.7 | 3.5 | 2.6 | 1.8 | 3.6 | 3.9 | 5.5 | 25.6 | 2.1 | 1.1 | 2.4 |
| H | 0.8 | 2.3 | 0.9 | 0.8 | 0.4 | 0.3 | 0.1 | 0.5 | 0.3 | 1.2 | 0.0 | 0.0 | 0.1 |
| C | 5.4 | 13.0 | 6.4 | 5.3 | 5.0 | 3.3 | 2.7 | 2.8 | 3.2 | 5.4 | 1.8 | 2.1 | 2.2 |
| NaCl | 9.8 | | | 0.5 | | 0.0 | | 2.9 | 1.5 | 0.4 | 2.9 | 0.1 | 1.7 |
| $CaCl_2$ | 2.3 | | | 0.2 | 1.3 | | 1.2 | 0.8 | 0.6 | 0.6 | 1.0 | | 0.9 |
| $CaCO_3$ | | | | | | 3.5 | | | | | | 0.2 | |
| $MgCl_2$ | trace | | | 0.0 | 1.0 | | | 0.0 | 0.2 | 0.0 | 0.0 | | 0.0 |
| $MgCO_3$ | | | | | | trace | 0.5 | | | | | 0.0 | |
| Total | 100.0 | 99.8 | 99.8 | 99.5 | 99.9 | 100.0 | 99.7 | 100.0 | 100.1 | 100.2 | 99.8 | 100.2 | 100.3 |
| Calc. Ign. Loss | 19.3 | 29.4 | | 16.5 | 12.8 | 11.1 | 10.7 | 7.1 | 12.9 | 21.5 | 11.1 | 13.0 | 11.8 |
| Detr. Ign. Loss | 19.3 | 29.1 | | 16.5 | 12.1 | 7.8 | 10.4 | 7.3 | 13.0 | 21.6 | 11.2 | 12.7 | 12.5 |

# Design and Operation of Baltimore Oil Foggers

by O. W. Lusby
Consolidated Gas Electric Light and Power Company of Baltimore

*Adapted from a presentation to American Gas Association Production and Chemical Conference*

THE new type of hot oil fogger developed for operations at Baltimore embodies the principles of heating the sweep gas rather than supplying direct heat to the oil; continuously contacting the hot gas with fresh oil, and continuously removing the residue of unvaporized oil from contact with the gas stream. The fogging rate is positively controlled through the rate at which oil is added to the gas by a controlled-volume pump.

Two years of trouble-free operation have demonstrated the advantages of this type of fogging equipment. The fog produced has excellent stability, and has been found widely distributed throughout the system.

A means of clearly establishing the presence of oil fog in the gas has been developed.

Approximately six weeks prior to the introduction of natural gas, we started oil fogging operations in an effort to assure an oil wet distribution system before conversion. When natural gas was temporarily introduced into the system at other points to facilitate conversion, small oil foggers were placed in operation at these locations to oil wet any dust present so as to prevent its movement.

In considering the conditioning of natural gas prior to conversion, it was decided to try to condition the mains so that they would continue to function the same with natural gas as when manufactured gas was distributed. This involved both humidifying and adding oil to the natural gas. In this way it was hoped that the leakage and dust troubles encountered by others after conversion to natural gas would at least be minimized.

An additional reason for the application of oil fog was to coat with oil the rust in the mains and thus reduce to a large extent the removal of the mercaptan-type odorant we were using. This removal is accelerated by the catalytic action of the iron oxide.

An investigation of the literature and a study of our previous experience indicated clearly that the hot oil fogger, which utilizes the principle of obtaining oil fog by suddenly cooling a hot gas stream carrying oil vapor, produces a fog of maximum stability and carrying power.

Our experience with oil fogging, covering a number of years, had brought to light many features which it appeared should be incorporated in the design of a hot oil fogger to obtain continuous trouble-free operation, adequate control of fogging rates and maximum fog stability. These factors are briefly as follows:

1. No heat should be applied directly to the oil. The necessary heat should be supplied to the "sweep" gas before contracting the oil to be vaporized. In this way the possibility of the carbonization of the oil on heat transfer surfaces with consequent adverse effect on fogging rates is avoided.
2. The heated gas should preferably be made to flow counter-current to the oil in order to obtain maximum vaporization of the oil for a given sweep gas flow and temperature.
3. In order to adequately control the fogging rate, the fresh oil should be added to the heated gas stream in a positively controlled manner which eliminates any possibility of flooding and over-fogging.
4. In order to maintain constant fogging rates, the spent oil residue should be removed continuously from the vaporization tower of the fogging equipment and not permitted to return to or mix with the fresh fogging oil.
5. The hot gas carrying the oil vapor should be introduced directly into the main gas stream. In this way the gas is cooled rapidly and a high concentration of fog particles is avoided and coalescence thereby reduced.
6. Open flames should be eliminated to reduce fire and explosion hazards. This permits the installation of these foggers at the most advantageous locations.
7. As a further safety measure, the heating of large volumes of oil in the fogger should be avoided. The design should also permit the storage of fogging oil at any convenient, safe location.

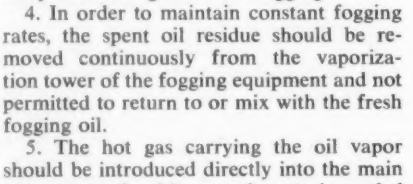


Figure 1. Oil fogger for low pressure stations, designed to fog 7.5 gals. of oil per day. Sweep gas 800-1,000 cu. ft. per hr.

We were unable to find on the market a hot oil fogger meeting these requirements. Foggers were therefore developed, incorporating the indicated features. Extensive experience has been secured by our operating department with all three types with entirely satisfactory results.

The first drawing shows a small fogger designed for an outlying station where oil requirements are limited to a few gallons per day.

This fogger was designed to operate at a station where the gas pressure is reduced. The sweep gas is passed through the fogger from the high to the low pressure main and the gas flow is controlled by adjusting the pressure regulator shown on the right of the drawing.

A solenoid valve follows the pressure regulator. With this arrangement the operation of the fogger can be made entirely automatic by connecting a timing device.

Following the solenoid is an orifice which may be used with either an indicating or recording flowmeter to measure the flow of sweep gas.

The cold sweep gas enters the bottom of the electric heater which has a capacity of four to five thousand watts. This type of fogger may be operated with a gas-fired or steam heater if it is desirable.

It is important that the gas pass up through the heater and that the thermoregulator controlling the gas temperatures be located at the top of the heater. With this arrangement, if the gas flow should be interrupted, heat from the heating elements will rise and the thermoregulator will cut off the current. As a further safety measure, we have employed two thermoregulators connected in series and arranged so that if the controlling regulator should fail, the second will operate at a temperature 50°F higher.

The temperature of the gas at this point is usually maintained at 350° to 400°F. However, it has been determined that temperatures as high as 500°F may be employed without decomposition of gas or oil. Use of higher temperatures permits increasing fogging rates substantially.

In passing up through the tower packing, counter-current to the oil flow, the hot gas heats and vaporizes the oil. The gas should leave the top of the tower at temperatures of 300 to 400°F, depending upon the boiling range of the fogging oil.

From this point the hot gas with oil vapor passes through an insulated line to the main gas stream where it is rapidly cooled by

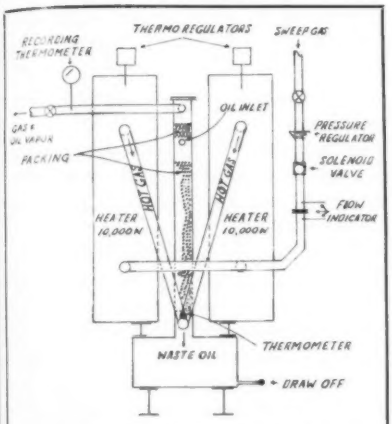


Figure 2. Oil fogger for high pressure stations designed to fog 10 gals. of oil per day. Sweep gas 5,000-6,000 cu. ft. per hr. Designed to operate at 150 psig and 400°F.

mixing with the cold gas, thus producing a stable fog. It is important that this line should be as short as possible. If a long line is required, heat should be added in order to prevent cooling of sweep gas and the condensation of oil vapor.

Approximately three inches of packing are placed in the tower above the point of introduction of the oil to reduce to the minimum the quantity of unvaporized oil carried in the gas stream.

The fogging rate is controlled by the rate at which oil is delivered to the tower.

We have followed the practice of supplying the oil by means of a small controlled volume pump equipped for adjustable feed rates.

Fresh oil is added continuously to the vaporizing tower and the unvaporized residue is collected in a reservoir at the bottom, out of contact with the gas stream. Not more than 80 to 90 per cent of the oil added should be vaporized in order that the residue may remain fluid and drain readily from the tower packing. The percentage of the oil vaporized may be controlled by either changing the sweep gas rate or the operating temperature.

The second drawing shows a fogger of the same type which was, however, designed for a distribution system operating at 100 to 120 psig.

The seven-fold increase in gas pressure requires the use of approximately seven times the quantity of sweep gas to secure the same oil vaporization rate as that obtained in a low pressure fogger.

The third drawing shows a large oil fogger designed for use at our principal distribution center where steam is readily available.

In this installation the sweep gas is heated by steam in a heat exchanger. In this design the oil is atomized into free space between layers of Raschig rings. This arrangement was used because we thought that the residue from the larger volume of oil for which this fogger was designed might clog a thick bed of tower packing. Experience has shown this precaution was not necessary.

The sweep gas rate has been about 20,000 cubic feet per hour and the oil fogged has averaged 50 to 60 gallons per day. During the past winter this fogger operated continuously without a single interruption. The oil residue drained from the bottom has been held at 20 to 25 per cent of that added. No solid residues have accumulated in the Raschig rings.

When foggers of this type were first placed in operation, the distance of travel and distribution of the fog were carefully studied.

The last fogger discussed, when placed in operation, was fogging oil at a rate of 50 gallons per day, which was equivalent to ¾ of a gallon of oil per million cubic feet of gas. When oil had appeared at four test points in the distribution system and could be definitely identified as fogging oil, these distances from the fogger were noted:

| | |
|---|---|
| Northeast test | 2.4 miles |
| North test | 8.8 miles |
| East test | 3.9 miles |
| South test | 6.1 miles |

Two additional test locations were installed and fogging oil was found:

| | |
|---|---|
| Northeast test | 7.5 miles |
| West test | 5.25 miles |

The excellent stability and transit of the fog produced by this equipment are also demonstrated by the fact that only negligible amounts of oil have been found in the mains close to the fogging locations. The excellent control is further demonstrated by the fact that no excessive oil has been found in customer service lines located close to the fogging points.

The fogging oil we use is a paraffin base oil which has been acid washed and distilled. It is made from selected stock to assure stability. Its distillation range is:

| | |
|---|---|
| 1 per cent over | 587°F |
| 5 | 596 |
| 20 | 601 |
| 50 | 610 |
| 70 | 623 |
| 90 | 646 |
| 99.3 | 668 |

The viscosity of the oil is approximately 50 seconds at 100°F, Saybolt Universal.

It has been our practice to condition new or dry systems with oil fog at a rate of 1½ to 2 gallons of oil per million cubic feet of gas. We believe about one gallon per million is sufficient once the system becomes oil wet.

Because of the high stability and carry of the fog made with this equipment these quantities are usually adequate. Higher fog concentration should be employed with caution because of possible trouble due to oil at customers' appliances.

## Summary of results

It has now been more than two years since straight natural gas was first introduced into our system. We have had no evidence of dust movement or trouble in any part of the system and have had no indication of more than the usual negligible leakage from our mains. A further benefit has resulted in that we have experienced only minor difficulty in obtaining sufficient concentration of the mercaptan-type odorant in all parts of our distribution system.

Our experience on several occasions has definitely established the fact that an oil wet system is a "must" for maintaining desired odorant concentration.

Based on these considerations, we believe that our extensive gas conditioning program, which includes humidification as well as oil fogging, has paid dividends in good service and freedom from trouble.

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NOTE: Application has been made for letters patent covering the novel features of the apparatus and method described herein. —EDITOR.

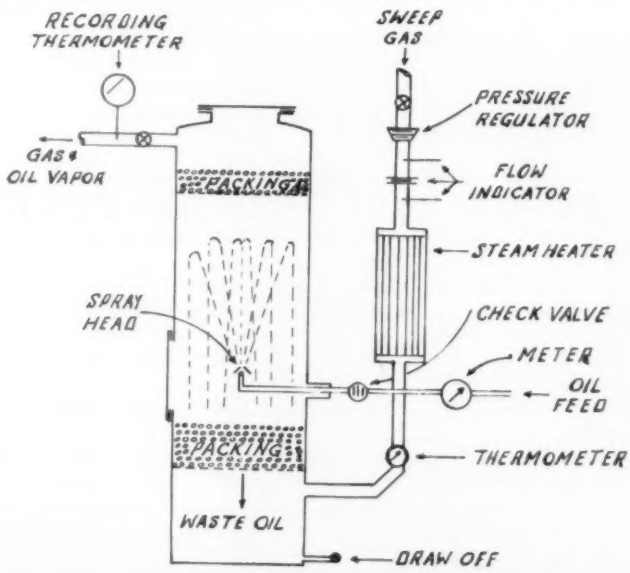



Figure 3. High capacity-low pressure oil fogger 30,000 cu. ft. steam heated sweep gas per hr. Designed to fog 100 gals. oil per day.

# Less Competitive Financing Seen for Gas Industry in Late 1952

by John F. Falvey

Financial Editor

John F. Falvey

UTILITY company stocks have given a commendable market performance, considering the tremendous volume of new offerings which have come to market during the recent past. No less than $313 millions of new common stock have been marketed to date this year by the electric, and combination gas-electric companies. That is 32 per cent above the total for the first half of 1951. While common stocks represented 28 per cent of all the financing done by this group of companies in the first half of this year, the proportion of equity offerings increased to 40 per cent of the total, in the record-breaking volume of new financing done in the month of June alone.

Comparable data is not available for the gas industry alone, but unofficial estimates of a $400-million-total of all utility common stock financing for the first six months of 1952 seem to be on the low side.

The electric and combination companies have been aided in their financing by improving general market conditions and by sharply increasing earnings. Recent earnings reports show net earnings gains running anywhere from 20 per cent to 40 per cent above year-earlier levels.

The operating experience of the gas industry, on the average, has been far less satisfactory. Gains where reported have been on a much smaller scale, and these have been liberally interspersed with declines from last year's totals. The pinch of increasing gas and other costs, and inability to obtain compensatory rate hikes, spell the reason.

The gas industry may be fortunate, however, in that the electric companies as a group seem to have completed the bulk of their financing for the year. With 1952 half completed, this segment of the utility industry has done better than 75 per cent of its estimated $1.5 billion of financing allocated to 1952.

Additional gas industry financing would come at a time when competition from electric company offerings would be lighter than for some time past. And it would have the benefit, also, of tremendously increasing funds for investment in the hands of individuals and institutions. Latest reports, covering the month of May, showed mutual savings banks gained more in deposits than in any comparable month in their history. And in the first five months of the year commercial banks gained better than one billion dollars in time deposits.

This increase in savings is stimulating the demand for high grade bonds and mortgages at just the time when a drop in construction activity is reducing the supply of mortgages.

Due to this combination of available funds and of a fairly light calendar of new corporate security offerings in sight for the early months ahead, no significant change in interest rates is anticipated now.

Alleviation of fears that a possible change in the Washington administration this Fall might lead to higher interest rates will forestall any trend by institutional and pension fund holders of bonds to shortening bond maturities.

At the most, only moderate increase in the money supply is looked for over the early months ahead.

Delay in obtaining needed steel supplies mean months of delay for the natural gas industry in consummating on schedule its tremendous additional expansion program projected for the five years ahead. Other deterrents to carry out the plan as contemplated are the lag in obtaining needed rate relief to offset sharply increasing costs; the Federal Power Commission rate-thinking, which recently has been leaning as low as 5½ per cent; and the expressed viewpoint of its own staff in at least one case that depreciation accruals should be lowered to less than three per cent annually.

As against this, however, is the state of flux in which the Commission's membership now finds itself, with one recess appointment and the possibility that a change in the Washington administration might lead to a more industry-minded majority opinion on the Commission.

Continuing to bulk large in stimulating investment buying of equities is the favorable trend of dividend payments. Increases in dividend payments to date this year have nearly doubled the number of decreases or omissions. From an unfavorable balance in the early months of 1952—during which casualties outnumbered increases—the trend has been favorable since the end of May, with increases being on the rise right up to the present.

## INDEX OF YIELDS : SELECTED UTILITIES STOCKS

| | July 1952 | June 1952 | May 1952 | Apr. 1952 | Mar. 1952 | Feb. 1952 | Jan. 1952 | Dec. 1951 | Nov. 1951 | Oct. 1951 | Sept. 1951 | Aug. 1951 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Gas Transmission Companies | 4.01% | 3.98% | 4.05% | 4.08% | 4.03% | 4.36% | 4.32% | 4.50% | 4.51% | 4.67% | 4.67% | 4.65% |
| Natural Gas Transmission & Distribution Companies | 5.26 | 5.28 | 5.32 | 5.34 | 5.14 | 5.29 | 5.17 | 5.33 | 5.30 | 5.36 | 5.09 | 5.11 |
| Manufactured & Mixed Gas Companies | 4.89 | 4.84 | 5.06 | 5.13 | 4.99 | 5.18 | 5.05 | 5.25 | 5.36 | 5.32 | 5.43 | 5.46 |
| Class "A" Electric Companies | 5.49 | 5.60 | 5.54 | 5.65 | 5.51 | 5.61 | 5.53 | 5.80 | 5.78 | 5.83 | 5.74 | 5.69 |
| Class "B" Electric Companies | 5.51 | 5.55 | 5.57 | 5.61 | 5.48 | 5.70 | 5.64 | 5.76 | 5.82 | 5.78 | 5.74 | 5.78 |

This is a straight arithmetical index of comparative yields obtainable on a selected group of gas and electric utility industry common stocks.

The companies comprising this index have been selected by the AMERICAN GAS JOURNAL as providing a representative cross-section of each industry, from the standpoint of geographical diversification and of the relative importance of the individual companies in their areas.

No effort has been made to weight the average to give effect to changes in capitalization or in dividend rates because the yields afforded on the issues reflect such changes. The index is designed to show the rate of return and not necessarily market movements on the stocks comprising it.

This index is compiled from: natural gas transmission companies, 5; natural gas transmission and distribution companies, 5; manufactured and mixed gas companies, 4; class "A" electric companies, 4; class "B" electric companies, 5.

# A Wheel Speeds the Work of PGW's Commercial Department

by John F. Quigley
Assistant Manager, Telephone Service Division
The Philadelphia Gas Works Company

THE newest innovation to speed operations in the commercial department of The Philadelphia Gas Works Company is the Wheeldex.

This is a device that, even in its early use, won the approval and admiration of all. Its adoption followed one of the most progressive steps taken by PGW in the change-over to the new IBM system for customer billing and accounting [American Gas Journal, February 1952].

Sweeping aside a long-established gas accounting system, the Magic Brain and other mysterious machines which make up our IBM installation, left in their wake the need for other related "reforms." Among them was the need to revise our customers index control, which many gas companies call the folio book.

In use since the centralization of the commercial department, in the early 1930's, the folio book served long and well. With the passing of time and the changing of systems, its days were numbered. Its unlamented passing brings to the scene something new and better.

The Wheeldex has supplanted the folio book.

About twenty years ago, Philadelphia was laid out in geographical areas for accounting control and meter reading routes. Each block of every street in the city was assigned a route book number. Route books in these geographical areas still make up our accounting controls. We have 200 controls and about 1,900 route books. The now-outmoded folio book contained the names of all the streets in the city.

"Name" streets were shown in alphabetical order, followed by the "number" streets. With each street shown, were the existing block numbers in numerical sequence. Next to each block number appeared the customers' control numbers and route book numbers.

When given an address of customer, a telephone representative looked in the folio book for the street, then the house block number which referred to the customer's folio.

While the folio book had been used in several departments of PGW for customer account location, it was used most extensively in the telephone service division of the commercial department. It is here that the largest number of billing and accounting inquiries, along with requests for service, are handled. Since customers seldom recall their own folio, it is necessary to have a quick-and-ready reference to identify the proper account location. Many hundreds of references to the folio book were made each day by the people in our telephone service division—nearly a million calls for service are received each year.

It was natural that telephone service people would be consulted, when the need for revision of the folio book followed other progressive steps taken recently in the commercial department.

One of the first considerations in the proposed change emphasized a reduction in the size of the source of the required information. Each telephone service representative has a 22″ x 28″ working area and each used a folio book in everyday work. Space is at a premium when compared with the full desk space in most other offices. Obviously, it was not considered practicable to maintain two types of folio books.

When the change was considered, the possibilities of a "wheel" were recognized immediately, for it combined compactness with speedier operation. Its size of 6″ x 7″ x 8″, no greater than a desk telephone, is ideal.

Transfer of the voluminous information from the old folio books became known as Operation Wheeldex.

Considerable time was saved with the utilization of tabulating cards which had been used in the change-over to IBM billing and accounting. These cards had been pre-punched for each block of every street in the city where meters are in use or where known-growth is expected to take place. Next, these cards were run through a sorter to be set up alphabetically and numerically.

A careful check indicated approximately 19,000 street listings, all of which had to appear on the cards of the new Wheeldex. Calculations indicated that three streets and twenty block listings were the maximum number that could be shown on one side of a card. But, it was apparent that this would not work smoothly since some streets have only a few blocks while others have many. This problem prompted the decision to use both sides of the cards. On the front: "Name" streets from "A" to and including "S." The reverse side: "Name"

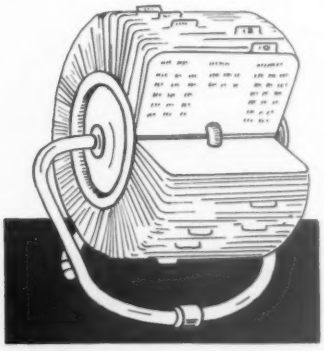
*Photos—PGW News*

This is a close-up of the Wheeldex in action at Philadelphia Gas Works Company, as a clerk in the telephone service division refers to information during a conversation with a customer.

streets from "T" to "Z," followed by the numbered streets.

Approximately 1,000 cards, 4" x 2", were required for *each* of the 155 wheels we purchased in this conversion.

Using 16-pitch micro-elite typewriters on Elliott addressing stencils, we prepared 1,425 stencils. These were sufficient to stock the 155 Wheeldex units



with a total of approximately 155,000 cards, printed on an Elliott printing machine.

In addition to the information previously shown in the old folio book for each house block number, the telephone number of the zone accounting clerk has been added. Consecutive numbers were assigned and recorded on each stencil as a means of identification. As a cross-reference, this number is important when both front and reverse sides of the card are used.

If an addition or a correction is made to only one side of a card, it is necessary to reprint both sides of the new card even though no change is made on the second side. Corrected cards are sent to the 155 Wheeldex users.

As Operation Wheeldex approached its final stages, cards were retained in original order until all of the 155,000 cards had been printed. As the cards were assembled on individual wheels, alphabetical and numerical guides were inserted and the Wheeldexes were ready for distribution.

### Advantages

1. Flexibility and ease with which changes can be made by merely substituting a card with additions or corrections. Assurance that corrections have been made is achieved by returning old cards to issuing offices.
2. Speedy and ready-reference. A spin of the wheel to the street listing provides instant information.
3. Space saver. The Wheeldex requires little space.
4. Provides a master file from which additional Wheeldex units may be printed when needed.

This progressive step, only one in the many now taking place in PGW, was far from a routine job for those who handled the mass of exacting detail during the transition from folio book to Wheeldex. The results, in terms of speed and accuracy, are gratifying.

**The compact equipment on a desk in PGW's telephone service division provides for speed and accuracy in handling customers' calls. Note the size of the Wheeldex, with 1,000 cards, and the size of the built-in telephone dial.**

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**GAS UTILIZATION**
- Combustion characteristics
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*** Indicates chapters published since January 1, 1951; available without charge to new subscribers to American Gas Journal.**

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AMERICAN Gas FUNDAMENTALS

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# *Principles of Absorption Refrigeration*

WHEN any liquid changes to a gas—in other words, when it evaporates—it always absorbs heat from its surroundings. The evaporation of water (perspiration) from our body surfaces helps to keep us cool in hot weather. The evaporation of liquid air can produce startling effects due to the rapid absorption of heat at very low temperatures. And between these two extremes there are countless other examples of the cooling effect produced by evaporation of a liquid.

Practically all commercially important refrigeration systems depend on evaporation of a liquid for the desired "refrigerating" effect. This is true whether the system is applied to a household refrigerator, a food freezer, the commercial production of ice or an air conditioning unit. It is true for both compressor and absorption type units.

If one chose to ignore economics—and certain other practical disadvantages—it would be possible to design a very simple refrigeration machine consisting only of an evaporator and a liquid refrigerant storage tank. Refrigerant from the tank could be fed to an evaporator coil where it would be allowed to boil and produce refrigeration. The disposition of the refrigerant vapor would present something of a problem, but presumably it could be expelled through a flue or to a sewer.

### *Evaporation Creates Cooling*

The familiar desert cooler, used in the Southwest for air cooling in automobiles and even in homes, presents a practical example of such a simple machine. In this case, the refrigerant (water) does not actually boil but evaporates by surface evaporation into dry air and absorbs heat from the air in the process. But water is the only available liquid which is cheap enough to use in this manner and the temperatures obtained are not low enough for most refrigeration and air conditioning purposes.

It is then an interesting fact that most of the additional components of the usual refrigeration unit are necessary only as a means of recovering the refrigerant vapor and of converting it to a liquid for re-use.

In the compressor system the refrigerant vapor is pumped from the evaporator mechanically and is then compressed to a pressure sufficient to cause condensation in a water-cooled or air-cooled condenser. The condensed liquid is then fed through an expansion valve (mechanical valve, capillary tube or orifice which allows the passage of liquid refrigerant but not vapor) to the low pressure evaporator where it again evaporates with the absorption of heat to complete the refrigeration cycle.

### *The Absorption System*

In the absorption system the refrigerant vapor from the evaporator is first absorbed into a liquid which has a strong affinity for the vapor. The refrigerant is then separated from the absorbent solution by boiling, through the application of high temperature heat, and the refrigerant vapor thus regenerated is condensed again to a liquid in a condenser. The condensed liquid is fed to the evaporator to complete the cycle, but in this case it is not always necessary that this be done through an expansion valve.

It will then be seen that there is considerable similarity between these two major types of refrigeration systems. Both obtain the refrigerating effect by evaporation of a liquid in an evaporator and both employ some means of recovering the refrigerant vapor for re-use. The main difference is in the use of the non-mechanical absorber and generator in the absorption system in place of a motor or turbine operated compressor.

When the absorption refrigeration system is described rhetorically as the production of "ice from heat," there seems to be an element of magic involved. But when we think of heat as a form of energy it does not seem so surprising that, when properly applied, this energy can be used to produce refrigeration.

### *Heat a Form of Energy*

As a matter of fact, the motor-compressor unit, too, is operated indirectly by heat energy. The electric current used to operate the motor is not itself a primary form of energy; it is merely a means of transmitting energy from the power plant to the point of use. And the generators in the power plant are operated by heat derived from burning coal, oil or gas. Even the hydro-electric power plant is fundamentally heat operated—in this case by the heat of the sun. Liquid water, vaporized by the heat of the sun at a low level, is carried to a higher altitude by heat generated air currents where it is condensed in the form of rain. This rain, flowing by gravity back to the level from whence it came, is then capable of producing electric and other forms of power.

The application of heat to produce cold in the absorption system might then be looked upon as a means of bypassing the power plant and the electric motor and of applying heat energy directly to produce refrigeration. The specific means by which this is accomplished is illustrated diagrammatically in Figure 1.

### *A Simple Absorption Cycle*

The EVAPORATOR in this system is, of course, the component which directly produces the refrigeration. It is generally in the form of a pipe coil or other enclosed metal structure designed for efficient absorption of heat from the surroundings. It is maintained at a low temperature, by the evaporation of liquid refrigerant internally, and is then capable of absorbing heat from brine, air or water, depend-

ing on the specific application. In the household refrigerator it is the place where ice cubes are made and frozen foods are kept frozen. It also provides the air cooling required to maintain low temperatures in the food storage compartment below.

The *refrigerant vapor* from the evaporator flows through a pipe or other type of conduit to the ABSORBER where it is brought into contact with a *weak absorbent solution* flowing from the GENERATOR. This solution, having a strong chemical attraction for the refrigerant vapor is capable of absorbing this vapor at a low pressure. The effect is then very similar to that of the suction stroke of a compressor, in that refrigerant vapor is accordingly "pumped" from the evaporator, thus always allowing space for incoming refrigerant liquid to evaporate at a low temperature.

The absorption of vapor by the absorbent solution is accompanied by the evolution of heat and this waste heat must be carried away as indicated by a *cooling medium* such as water or air.

The *strong solution* (strong in refrigerant), resulting from the combination of weak solution and refrigerant vapor in the absorber, is then transferred to the generator where high temperature heat is applied and the solution is caused to boil. For reasons which will be discussed later, the pressure in the generator is normally higher than in the absorber. In large commercial installations, a mechanical pump is often used to pump the strong solution from the lower pressure absorber to the higher pressure generator. In other applications, unique methods have been employed to avoid the use of a mechanical pump and obtain units with no moving parts. This phase of the subject will be discussed later.

### Behavior of Refrigerant Vapor

The preferred source of heat for the generator is a gas burner, since this usually results in the simplest, cleanest, most inexpensive design and the most economical operation but, of course, other sources of heat may also be employed. The boiling of the solution in the generator results in separation of refrigerant vapor from the absorbent solution. This vapor flows through a conduit to the CONDENSER where it is condensed to a liquid, the heat of condensation being carried away by a cooling medium such as air or water.

Since the refrigerant is being condensed at a temperature well above the evaporating temperature in the evaporator, the pressure must necessarily be higher. The actual pressure will depend largely on the refrigerant used and the temperature of the cooling medium. As in the case of the compressor system, there is then a high pressure side (generator and condenser) and a low pressure side (evaporator and absorber). In order to prevent by-passing of uncondensed refrigerant vapor from the high pressure to the low pressure side there must normally be some type of *expansion valve*, to control the flow of liquid refrigerant from the condenser to the evaporator and a similar device to control the flow of solution from the generator to the absorber.

One component, a liquid heat exchanger, was omitted from the diagram in Figure 1 for the sake of simplicity. It is not actually a necessary part of the absorption system but is usually included for the purpose of obtaining maximum thermal efficiency.

The weak solution leaving the generator is relatively hot, since it is at its boiling temperature. If this solution is introduced directly into the absorber, it must give up some heat to the absorber cooling medium before it can become cool enough to absorb refrigerant vapor. On the other hand, the strong solution leaving the absorber is at a relatively low temperature, since it is constantly cooled by the absorber cooling medium. It will then be several degrees below its boiling point under the higher pressure maintained in the generator. If this solution is pumped directly to the generator, additional heat will be required to raise the temperature to the point where boiling can occur and refrigerant vapor is produced. This is obviously wasteful since the resultant refrigeration depends on the production of refrigerant vapor (and liquid) and none is produced by this additional heat.

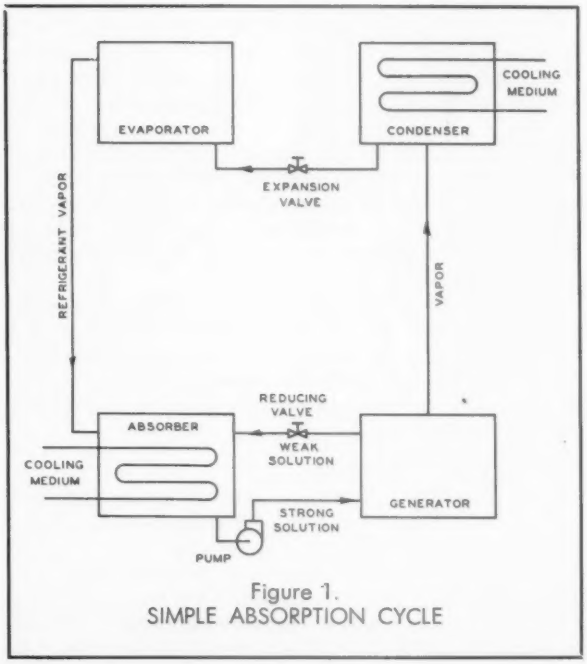



Figure 1.
SIMPLE ABSORPTION CYCLE

### The Heat Exchanger

The liquid heat exchanger is a device for transferring (exchanging) heat from the hot weak solution to the cool strong solution, thus eliminating the necessity for the additional heat in the generator. This is done by bringing the two solutions in contact with opposite sides of a metal wall so that heat may be conducted from the hot solution to the colder solution through the dividing wall. Such an exchanger usually takes the form of a double concentric pipe arrangement with one solution flowing through the inner pipe and the other solution flowing in the opposite direction through the annular space enclosed by the outer pipe. Parallel plate type exchangers are also used for this purpose.

There are numerous combinations of refrigerant and absorbent liquids that might be used for absorption refrigeration but for various reasons a certain few are very much better than the others. Solid absorbents have also been used experimentally and some refrigeration units have been produced commercially with such absorbents. To date, however, they have not generally proven satisfactory.

The aqua-ammonia system represents the best known example of the absorption type refrigeration unit. In this system, ammonia is employed as the refrigerant, and water (or more precisely, weak ammonia-water solution)

is used as the absorbent. This combination is used almost exclusively today in absorption units for low temperature application. It is used for many commercial purposes, as for example in the manufacture of ice, and it forms the basis for the well-known Servel household refrigerator.

### *Eliminating Moving Parts*

The Servel refrigerator unit represents an outstanding example of a novel method of avoiding the use of a mechanical solution pump, thus eliminating all moving parts from the refrigeration system.

The first step in achieving this result is the introduction of an inert gas phase for the purpose of equalizing the pressure throughout the unit.

Sufficient inert gas is introduced so that the total pressure of gas and ammonia vapor in the evaporator and absorber is raised to that of the ammonia vapor pressure in the generator and condenser. The high and low sides of the unit are inter-connected in such a way that the inert gas can pass freely from one to the other without any by-passing of refrigerant vapor. This provides a means of automatically equalizing the pressure between the two sides under variable operating conditions. The elimination of the pressure differences between the absorber and the generator then makes it possible to employ gravity flow in place of a mechanical pump for circulation of solution between these two components.

### *Heat Supplies Motive Power*

Of course, solution circulation cannot be maintained without some motivating force and this brings in the second step in this development. As the solution is boiled in the generator, it is also lifted through a height of several inches by what is called "vapor lift action." This action is exactly comparable to that occurring in a coffee percolator where steam produced by boiling the water in the coffee pot bubbles up through a central tube and in so doing carries liquid with it to be distributed over the coffee grounds above. The main difference between these two examples of this type of pumping is that in the refrigerant generator the pumping rate is accurately controlled by design to give the most effective solution circulation rate.

The third and equally important step was the selection of the inert gas used for pressure equalization. Hydrogen was selected because of its light weight or, more properly, low density. In order to explain the importance of this point, it is necessary to consider a change in the operation of the evaporator that is brought about by the introduction of inert gas.

In the previous discussion it was pointed out that liquid refrigerant is made to boil in the evaporator by reducing the pressure. But the introduction of inert gas equalizes the pressure throughout and thus eliminates this pressure-lowering. How then can the liquid ammonia evaporate and produce refrigeration?

### *How Refrigerant Boils*

In technical terms the answer is that although the total pressure is no longer reduced by action of the absorber, the partial pressure of ammonia in the inert gas is reduced and liquid ammonia can then evaporate by surface evaporation and diffusion into this gas.

The situation is exactly analogous to that of cooling of the body by evaporation of surface moisture into the atmosphere. When the air is dry—in other words, when the partial pressure of water vapor in the air is low—the body is cooled rapidly by surface evaporation. On the other hand, when the partial pressure is high (high humidity) we generally experience acute discomfort due to lack of surface evaporation. The application of this principle to the absorption refrigerator can be more clearly brought out with reference to the simplified diagram in Figure 2.

### *Vapor Lift Replaces Pump*

It will be seen that we have here all the normal components of the simple absorption refrigeration unit with the exception of a mechanical solution pump. This has been replaced by a vapor lift or percolator type of pump which lifts solution from the GENERATOR to a height from which it can flow through the ABSORBER and back to the generator by gravity.

An additional circuit has also been added to provide for the circulation of inert gas through the EVAPORATOR and absorber as indicated. Liquid ammonia flows to the evaporator from the CONDENSER in the normal manner except that the expansion valve has been replaced by a simple *liquid trap*. This is possible because of the equalization of pressure. In the evaporator the *liquid refrigerant* (ammonia) is brought into contact with dry *hydrogen* coming from the absorber. As both liquid and gas flow through the evaporator, the gas becomes practically saturated with ammonia vapor. This saturated or *rich gas* then flows down to and through the absorber where it is brought into contact with *weak absorbent solution* from the generator. The absorbent solution removes ammonia from the gas (dries it) so that it will be ready to pick up more ammonia vapor after it flows back up to the evaporator.

### *The Role of Hydrogen*

The one remaining question is how the hydrogen is made to circulate continuously, and in the right direction, while the unit is in operation. Here again, the natural force of gravity is brought into play.

Hydrogen stripped of ammonia vapor is very much lighter than a mixture of hydrogen and ammonia vapor at the same pressure. The nearly-pure hydrogen leaving

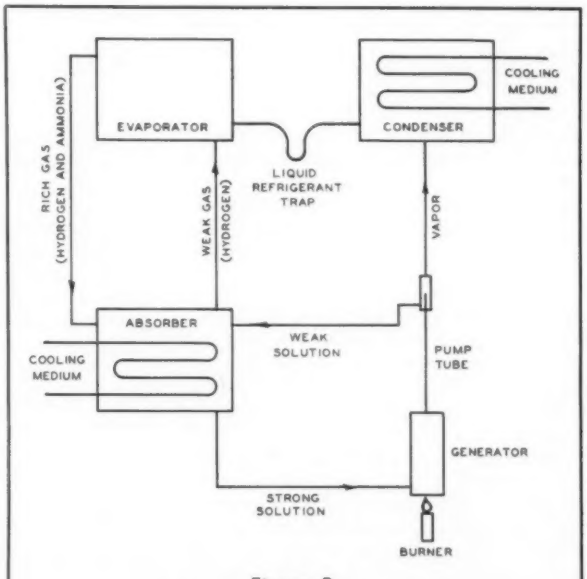



Figure 2.
SERVEL REFRIGERATOR UNIT

the absorber will therefore be much lighter than the saturated gas mixture leaving the evaporator. By providing separate but connected paths of flow for these two gases, the lighter gas can then be caused to rise through one tube while the heavier gas descends through another.

Thus, the processes of evaporation and absorption themselves provide the basic force which maintains the gas circulation on which evaporation and absorption depends. Sounds a little like perpetual motion but, of course, it is not. The primary source of energy for the whole process is still the heat applied to the generator.

The absorption system used in the cooling unit of the Servel all-year air conditioner provides another example of a successful method of avoiding a solution pump. The refrigerant in this unit is water and the absorbent is a water solution of lithium bromide. Water can be used as the refrigerant in this case, since the evaporator is not required to operate below the freezing point.

### *Low Operating Pressures*

The use of this relatively high-boiling liquid as refrigerant results in very low operating pressures—in fact, the unit operates under a relatively high vacuum. Since the total absolute pressure is low, the pressure difference between the high and low sides must also be low, the actual difference being equivalent to only a few inches of liquid head. This being the case, it is possible to apply the vapor lift pump and gravity flow system without the introduction of a pressure equalizing inert gas. The unit then remains as a two-pressure system, the high and low sides being separated by solution columns.

The above discussion of the absorption refrigeration system has necessarily been confined to the relatively simple fundamentals. No attempt has been made to cover the equally important details of design and operation which have been the major subject of research and development for many years.

### *Trouble-free Operation*

Probably the most important of these details are concerned with assuring long life and trouble-free operation under widely and often rapidly varying conditions. It is an established fact that properly-designed and -manufactured absorption refrigeration units do provide unusually long and dependable service over a wide range of conditions. This is due largely to the minimum, or complete absence, of moving parts and to the general ruggedness of this type of refrigeration unit.

The absorption system has always had an important place in the refrigeration industry, which place has become more and more firmly established through the years. It is predicted confidently that the importance of this system will increase at an accelerated rate in the years ahead.

This chapter on Principles of Absorption Refrigeration was prepared by Dr. Norton E. Berry, Director of Research, Servel, Inc., Evansville, Indiana

# Above-Ground Gas Piping Within Industrial and Commercial Premises

Suggestions prepared by

**A. D. Frydendall**

The Peoples Gas Light and Coke Co.

The following suggestions regarding piping installation may be of assistance to the engineer faced with the problem of recommending, installing, or supervising gas lines within industrial and commercial premises.

### Importance of Rules

All gas piping and the installation thereof should conform to the local ordinances and any regulations established by the gas company. Gas should not be turned on unless and until these ordinances and regulations are complied with.

### Work for Authorized Agencies

All gas piping should be approved by the local authority having jurisdiction over such matters. Only authorized employees of the gas company should be permitted to install, connect, or disconnect meters, break seals, remove locks or turn on gas to the premises. Close contact with the gas company will facilitate prompt attention to these matters and reduce delays.

### Pipe and Fittings

All pipe for building services, risers and fuel lines should be of standard weight (ASA Schedule 40) for pressures up to 125 psig. For higher pressures, piping should be in accordance with the ASA code for Pressure Piping B 31. 1. Welded joints are preferable, but screwed and flanged joints may be used. Plain end pipe with gland type couplings may be used if the pipe is suitably braced to take care of end thrust. Fittings should be of steel or malleable iron in pipe sizes under 4-inch. For sizes 4-inch and over, fittings of malleable iron, cast iron, steel or welded fittings, either shop or field fabricated, may be used.

Flange gaskets may be either of the full face or ring type and should be made from a standard grade asbestos composition sheet packing. Packing for gland type joints used with plain end pipe shall be of an oil-resistant synthetic rubber for manufactured gas and otherwise of first grade compounded rubber or approved equal and should have all surfaces clean and free of rust or dirt when installed.

### Shut-Off Valves

Shut-off valves should be of either the lubricated plug cock or gate valve type. Cocks other than the lubricated plug type are not recommended in sizes larger than 2-inch.

*Adapted from an American Gas Association Newsletter, issued by Industrial Practices Committee*

### Emergency Shut-Off Valves

Manual shut-offs, consisting of lubricated plug cocks or gas valves, should be provided in large industrial piping systems and located so as to permit cutting off the gas supply to buildings, ovens, furnaces, etc., in an emergency. These emergency shut-offs should be accessible in event of an accident, and their locations should be posted on building walls or columns.

### Unions and Bushings

Unions or bushings should not be used in piping that is to be concealed. Unions should be placed on the burner or appliance side of shut-off valves. Reducing couplings are to be preferred to bushings. Bushings under 2-inch pipe size on the male side should not be used. When bushings are used they should reduce no less than two pipe sizes, otherwise their wall thickness is inadequate.

### Expansion Fittings

When cast iron fittings of either the screwed or flanged type are used on pipe 6-inches and over, suitable expansion bends or gland type couplings should be used to compensate for expansion and contraction. When expansion bends are used, they should conform to good practice in regard to radius, uniformity of curvature, and uniformity of wall thickness. Where gland type couplings are used, they should be located where they can be readily inspected and maintained, and under no circumstances should they be installed in a confined area. Packing designed for gas should be used with gland type couplings.

### Supporting Pipe

All piping should be securely fastened and supported with proper hangers at intervals to prevent sagging and trapping. A building service, riser or fuel run should not be hung, strapped or supported from a water, steam, sewer or other pipe or electric conduit. The practice of supporting pipe on outside building walls should be avoided wherever possible since building settlement may cause sagging or rupture of the line.

### Workmanship

All piping should be installed in a neat workmanlike manner, free from traps and properly graded down (no less than one inch in twenty-five feet) to risers, drops or to a suitable connection at the appliance. Where expedient for removal of foreign matter, a tee with a nipple in its bottom opening properly capped may be used in the low point of the line.

After the pipe has been cut and threaded, the ends should be reamed to remove cutter burrs and the entire length of pipe thoroughly swabbed internally to remove chips, oil, scale and dirt before putting in place. Gas piping with threaded joints should be made up with standard tapered pipe threads with an approved pipe joint compound applied to the male thread only.

On welded construction, each length of pipe should be thoroughly swabbed internally before being welded into place and precautions should be taken to prevent welding beads or other projections from remaining inside the pipe.

### Test Pipe

A test connection of not less than ⅜ inch pipe size should be installed on a riser or fuel run and a pipe extended so that pressure tests can be made when standing on the floor.

### Final Testing and Inspection

Before the piping is finally approved and appliances connected, a test for tightness should be made by the contractor and observed by a qualified representative of the authority responsible for final approval. To test for tightness, the system should be subjected to a test pressure of at least 1.5 times the maximum working pressure, but never less than 6 inches of mercury or 3 psig. The system should hold this bottled up pressure for a period of time depending upon the size of the system but not less than ten minutes without showing any drop in pressure after the test gas in the pipe has been given time to arrive at room temperature.

For test purposes, air or an inert gas such as carbon dioxide, nitrogen or products of combustion (but not oxygen) should be used as a pressure medium. The use of water for testing is not recommended.

After appliances are connected, the piping should stand a pressure of 1.5 times the working pressure but not less than one inch mercury column or ½ psig. without showing any drop for a period of at least 10 minutes after room temperature in test gas has been reached.

No flame in any form should be used in testing for gas leaks. Such tests should be made by brushing a soap and water solution or its equivalent on the joints.

### Defective Material

Defective material should be removed and replaced with new material. Welded joints may be repaired by rewelding. The use of cement, lead, caulking or peening to stop leaks or repair fittings should be prohibited.

### Purging

After the piping has been approved and meter set, the piping should be purged at the most distant point from the meter, by a hose or temporary pipe line to the outside of the building through a water seal. When purging pipe 4-inch and larger, it is recommended that an inert gas be used. Short small lines may be purged direct to the atmosphere by removing a cap or plug in the gas line outside the appliance so that there will be no pocketing of gas within the equipment, which might create a hazard.

*(Continued on page 29)*

# The Gas Industry Can Avoid Some Legal Pitfalls

by Leo T. Parker

Attorney at Law
Cincinnati, Ohio

THE operations and governing laws pertaining to the gas industry are well-filled with legal pitfalls that should be recognized and considered for the possibilities of avoiding some of them. Conversations with gas company executives, during a recent survey trip, brought forth a number of instances in which gas companies had found themselves in disadvantageous positions.

### Liquidated damages

A reader asked, "Recently our gas company filed a suit to collect a penalty or liquidated damages from a large gas consumer who breached his contract to use a minimum quantity of gas each month for three years. Can we collect damages?"

Generally, contracts for a penalty or liquidated damages are void. Therefore, you cannot collect unless your company proves that actual damages were sustained.

For many years, higher courts have held contracts void which stipulate a penalty to be paid by a contracting party who breaches a contract. The courts hold that the "measure of damages" recoverable against a person or company for failure to fulfill the terms of a contract is the *actual loss* sustained by the party.

For illustration, a consumer contracted with a gas company to purchase a specified quantity of gas. The contract contained a clause by which the consumer guaranteed that if he failed to fulfill the terms of the contract he would pay the gas company a large sum of money as "liquidated" damages.

The consumer breached the contract, and the gas company filed suit to collect the specified liquidated damages. Although the lower court held the consumer liable, the higher court reversed the verdict, saying:

"A provision of a contract, which undertakes to fix a penalty as liquidated damages for the breach of a contract . . . is void, if the actual damages which may be suffered by the seller through the breach of the contract are not susceptible of proof." See Home v. Robinson, 40 Pac. (2d) 637.

Hence, although ordinarily a contract is void when specifying a penalty or liquidated damages, yet such a stipulation may be valid to the degree that actual damages are proven. Quite obviously, therefore, under normal circumstances a "penalty or liquidated damages" clause has little practical use, because one who breaches any contract always may be sued and compelled to pay reasonable damages to the other contracting party.

### Law of interstate taxation

Another reader asked, "Is a state law valid which taxes gas corporations that transact interstate business in the state? If a state may tax interstate business, under what specific conditions may it do so?"

It is well to explain that the Supreme Court of the United States has rendered several decisions to the effect that a state may not impose any tax which is a direct burden upon interstate commerce. On the other hand, the late courts have made important distinctions between state taxation laws relating to gross receipts and net income. The higher courts now consistently hold that while state laws are void which tax gross receipts of interstate business, yet a similar law is valid which taxes so much of the net income derived from interstate commerce as is properly apportionable to operations or business within the state.

In the case of State Tax Commission v. Memphis Natural Gas Company, 19 So. (2d) 477, it was shown that a gas company owns certain real and producing property in Louisiana and sells gas to various municipalities in Mississippi. The gas is delivered through its pipe lines extending from Louisiana into Mississippi. These pipe lines are used exclusively for transporting gas interstate. The Mississippi Legislature enacted a law which provides that each foreign corporation shall pay a specified tax on its net income derived from all property owned and from every business, trade or occupation carried on in this state.

The counsel for the gas company contended that this Mississippi taxation law was not intended to apply to foreign gas corporations doing an interstate business exclusively, and that the law is void and in violation to the commerce clause of the United States Constitution, Article I, Section VIII.

The higher court refused to agree with these contentions and held the gas corporation liable for payments of taxes on its net income derived from interstate business in Mississippi.

This court said, "The difference in effect between a tax measured by gross receipts and one measured by net income, is manifest and substantial. . . . A tax upon gross receipts affects each transaction in proportion to its magnitude and irrespective of whether it is profitable or otherwise. A tax upon the net profits has not the same deterrent effect, since it does not arise at all unless a gain is shown over and above expenses and losses, and the tax cannot be heavy unless the profits are large."

For a comparison, see State v. Gulf, 104 So. 699, in which this court upheld the validity of a state law which taxes the net income derived from a corporation's interstate business.

"If the tax were on gross income a serious question would here be presented," the court said. "But it is not on gross but on net income and a tax on net income, derived in whole or in part from interstate commerce, is not a burden thereon within the meaning of this clause of the Federal Constitution."

For further variations of the law on the subject of valid state taxation on interstate business, see these Supreme Court of the United States decisions: United States v. Oak Creek, 247 U. S. 321; Underwood v. Chamberlain, 254 U. S. 113; Shaffer v. Carter, 252 U. S. 37; and Atlantic v. Daughton, 262 U. S. 413.

### Verbal contract is void

A reader asked, "I have heard that a contract for more than one year is void unless in writing. Is this the law?"

Modern higher courts consistently hold that under ordinary circumstances contracts are void which cannot be performed within one year. For example, in a leading higher court case, Ford, 132 S. W. (2d) 46, the higher court held that a seller could not recover damages on a breached verbal contract which extended over a period of three years.

This law is especially applicable to contracts for the sale of gas and all other commodities. Also, under all circumstances and in all states, contracts relating to real estate are void if the contract cannot be performed within a year from its date.

With respect to contracts for the sale of gas, verbal contracts that cannot be performed within a year may be rendered valid if the parties correspond regarding details of the agreement. See Whitten, 148 Fed. (2d) 121. Here it was held that if a buyer and seller *correspond* regarding a verbal contract, and arrange details, the verbal contract as-

sumes the importance and legal status of a written contract.

For a comparison, see Hopper, 146 Fed. (2d) 364. This higher court held that a verbal contract is valid although it specifies a period more than one year, providing either party has the privilege of cancelling the contract within one year. This court said, "If the contract, by its terms, is not to be performed within a year, it is void; but if it may, by its terms, be performed within a year, it is not void even though it may not be performed, or is not likely to be performed, within that time. . . ."

Accordingly, if a verbal contract contains any clause or stipulation which permits either party to cancel the contract or otherwise stop performance within a year, the contract is valid and enforceable.

### Within scope of employment

A reader asked, "Can an employee collect compensation under the state compensation laws for an injury he sustained while going from his home to his place of employment?"

The answer is yes, if the employer transports the employee from his home to the place where he begins work, or if the employee is injured while traveling or going to perform some special services for his employer.

The higher courts consistently hold that the criteria of a compensable accidental injury are: *first,* was the employment one of the contributing causes without which the accident would not have happened and, *second,* was the accident one of the contributing causes without which the injury would not have been sustained. If so, the injured employee is entitled to receive compensation under the state workmen's compensation act.

On the other hand, an injured employee not protected by the state workmen's compensation act may recover *damages* from the gas company *only* when the evidence proves that the injury resulted from *negligence* of officials of the company. But, as indicated above, an employee may receive compensation payment under the state workmen's compensation act whether or not the injury was caused by negligence of his employer if the injury was incurred "within the scope of employment."

Broadly speaking, an injury arises "out of" the employment, when there is a casual connection between the conditions under which the employee is *required* to perform his work, and the resulting injury, Therefore, an employee who is required to perform special services is "within the scope of the employment" the instant he leaves his home to perform such special services.

In Eargle v. South Carolina Electric and Gas Company, 32 S. E. (2d) 240, it was shown that an employee of the company lived across a river from the company's plant. One evening the employee was given special instructions to report for work the next day, which was a holiday, at 8 AM, as a member of an emergency shift. He left his home about 7:20 AM and endeavored to cross the river alone in a boat. He was drowned. His dependents sued the gas company to recover compensation under the state workmen's compensation act.

The lower court refused to allow compensation on the grounds that the accident did not occur "within the scope of the employment," since the employee had not reported for work when the accident occurred. However, the higher court reversed this verdict and, in holding the dependents entitled to recover compensation, the higher court said that an important element of testimony in favor of the dependents was that the evening before the accident the employee had been especially instructed to report for work for special services on a holiday. Thus the court held the accident arose from the employment.

### "Market value" of gas

Another reader asked, "What is meant by 'market value' of gas? Some states have enacted laws requiring payment of special taxes on the 'market value' of gas. On what gas price can the state collect these taxes?"

According to a late higher court decision, the "market value" of gas is the price at which it is sold, under ordinary conditions by producers of gas. The "market value" of gas, as a basis on which producers pay taxes, is the *exact* price at which they sell the gas and not the price at which gas is sold for industrial and domestic purposes.

For example, in W. R. Davis, Inc. v. State, 180 S. W. (2d) 429, the state taxing officials sued a gas producer to recover taxes under a state law which provides that the producer shall pay a specified tax based on the "market value" of all gas produced and sold by him. The state officials contended that the producer must pay taxes based upon the price at which the purchasers resold the gas. However, the higher court refused to agree with this argument.

"It was not the intention of the Legislature" the court commented, "to have more than one standard of value, and such would be the case if it were held that in some instances 'market value' in the ordinary meaning of that term is meant, while in other instances the sale price is meant if the producer sells for more than the 'market value.' . . . Of course, the purchaser can never be liable for any greater tax than the producer is liable for."

## Above-Ground Piping Within Industrial Premises

*(Continued from page 27)*

CLOSING OPENINGS

All openings should be securely closed with iron caps, plugs or blind flanges until appliances or fixtures have been connected.

BACK PRESSURE VALVES

When air at a pressure higher than the normal gas pressure is used to support combustion and suitable protection is not otherwise provided, a check valve approved by the gas company should be installed in the piping at the outlet of the gas meter. If such a valve is not installed, a gas meter should not be set.

FLAME ARRESTERS WITH $O_2$

When oxygen or nitrous oxide is used on an appliance to support combustion, an approved flame arrester should be installed at the appliance or group of appliances together with an approved check valve to prevent these gases from entering the gas piping.

PIPING SUBJECTED TO LOW TEMPERATURES

When it is necessary to run pipe on or along an outside wall, a furring strip should be placed between the pipe and the wall. If lines carrying manufactured or mixed gas are subjected to low temperatures, the pipe should be protected with a suitable covering of insulation.

PIPING IN UNSATISFACTORY LOCATIONS

Gas piping should not be exposed to varied or sudden changes of temperature, as might be obtained by running through hot air furnaces, cold air ducts, refrigeration rooms, ice boxes or to any outside exposures where freeze-ups might occur.

Gas piping should not be buried in or under floors of buildings or in places where proper ventilation cannot be provided.

GAS PIPING USED AS ELECTRICAL GROUNDS

Gas piping should not be used as a ground for electrical equipment.

PAINTING

It is recommended that all gas piping be painted an identifying color in accordance with the approved specifications of the American Standards Association.

## OPS Upheld in Rate Interventions

Authority to intervene in rate increase cases before Federal Power Commission was maintained by Office of Price Stabilization under provisions of the amended Defense Production Act that became law June 30. The bill amending the act, as passed by the House, removed the authority on which OPS intervened in rate cases filed by public utilities that are subject to state or Federal regulatory agencies. The Senate version of the same bill included the authority for OPS and, subsequently, the Senate and House conferees disapproved the withdrawal of the authority.

As the amended bill became law, OPS has the authority to continue its interventions in rate cases pursuant to applications before state commissions and FPC.

# News of the Gas Industry

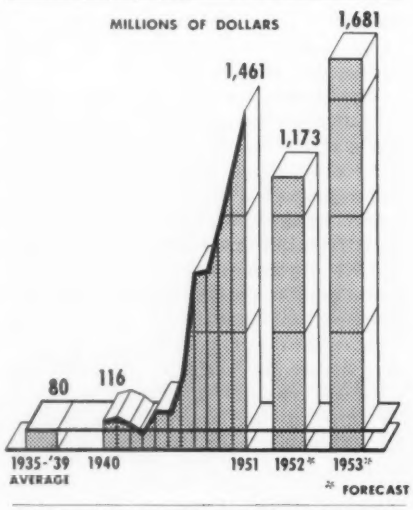
## FIVE-YEAR SPENDING BY INDUSTRY: $5.6 BILLIONS

The gas distribution and pipeline industry will spend about $5.6 billion for construction of new facilities and expansion in the next five-year period, 1952-through-1956, American Gas Association has estimated. This compares with construction expenditures of 5.1 billion dollars over the past five years, a previous high record in the gas industry.

The natural gas branch of the industry expects to spend $5,099,000,000 in its five-year expansion program, compared with $4,560,000,000 spent in the 1947-1951 period. Expanded transmission facilities are estimated to cost $3,075,000,000, with $415,000,000 allocated to production facilities and $82,000,000 estimated for underground storage expansion.

All other types of gas will account for about $500,000,000 in new construction in the next five years. Expanded distribution facilities will cost approximately $302,000,000, and $150,000,000 will go to production and storage facilities.

### GAS INDUSTRY EXPENDITURES
New Construction and Expansion
1935-1953




*Source: American Gas Association*

### GAS UTILITY CONSTRUCTION EXPENDITURES
New Facilities and Expansion
By type of gas and plant function
1947-1956

| Type of Gas and Plant Function | Actual 1951 | Actual 1947-1951 | Forecast 1952-1956 |
|---|---|---|---|
| | (. . . *millions* . . .) | | |
| Natural Gas | $1,363 | $4,560 | $5,099 |
| Production | 124 | 511 | 415 |
| Transmission | 867 | 2,939 | 3,075 |
| Underground storage | 42 | * | 82 |
| Other storage | 15 | * | 38 |
| Distribution | 271 | 958 | 1,337 |
| General | 44 | 152 | 152 |
| Other Types of Gas | 98 | 586 | 496 |
| Production and storage | 19 | 221 | 150 |
| Transmission | 6 | 23 | 11 |
| Distribution | 66 | 314 | 302 |
| General | 7 | 28 | 33 |
| Total Industry | 1,461 | 5,146 | 5,595 |
| Production; other storage | 158 | 732 | 603 |
| Transmission | 873 | 2,962 | 3,086 |
| Underground storage | 42 | * | 82 |
| Distribution | 337 | 1,272 | 1,639 |
| General | 51 | 180 | 185 |

* Included in production

## J. A. McBride is Buell VP&GM

J. A. McBride has been named general manager and vice-president in charge of sales, Buell Engineering Company, Inc., New York, according to an announcement of the company's board of directors. Mr. McBride has been sales manager since 1938.

## Committee Working on Piping Code

At a three-day meeting of a newly organized American Gas Association subcommittee, in Chicago recently, work was begun on the formulation of a safety code covering material, design, fabrication, installation, testing and operation.

## New California Project Is a First

A first was scored by Southern Counties Gas Company when Petroleum Administration for Defense approved installation of a 16-inch pipeline south from San Luis Obispo toward Arroyo Grande in the company's northern division.

Initially, this 17,000 foot section will be used for the sole purpose of providing an additional million cubic feet of much needed gas storage for the city of San Luis Obispo.

Some years later, as the need develops, the section will become a part of a 16-inch gas transmission pipeline paralleling the present 8-inch line from San Luis Obispo to Arroyo Grande.

This is the first time in the history of the gas industry, according to the information at hand, that any such long-range pipeline construction program has been planned with the idea of first supplying presently needed gas storage and later providing the additional transmission facilities that growth studies show will be needed.

## Laclede Studying Storage Area

Laclede Gas Company will start immediately the advanced geological work intended to develop a natural gas reservoir about one-third of a mile beneath the surface of approximately 25,000 acres north of Florissant in St. Louis and St. Charles counties, Mo. The object of the project is to provide storage for about 20 MMMcf for winter-time peak use in the St. Louis area.

Storage of gas in an existing huge dome-shaped and gas-tight rock formation more than 1600 feet underground will enable Laclede to serve about 50,000 more house-heating customers than at present, Robert W. Otto, Laclede president, said.

He emphasized that much geological and geophysical work remains to be done before a final decision that the rocks beneath the Florissant area are suitable. If this particular area should not measure up to expectations, attention will be directed to other areas near St. Louis that have storage possibilities. Information supplied by the State Geological Survey and studied by the company's consulting geologists warrants concentrating on the Florissant area first.

The project is estimated to cost ultimately about $10,000,000.

## Distribution Award Announced by AGA

A new award for distinguished achievement in the field of gas distribution, announced by American Gas Association, will be made under the auspices of the operating section through the sponsorship of American Meter Company, Philadelphia.

The purpose of the award is to give recognition to the individual who has made the most outstanding contribution to gas distribution during the current year, or for an outstanding contribution during the five years preceding the year in which the award is made. In the future, the years for the award will be dated from May 31st, or such other date as the Association may later adopt. Entries for this year's award may be mailed until August 18.

The award will consist of a cash prize

of $1,000 with a certificate and a suitable token. It will be presented at the AGA Annual Convention. Individual members of AGA, employees of member gas companies, holding and service companies are eligible.

Contributions on which the award is to be made may include a plan, design, program or any other act which adds to the safety, economy, efficiency or the service of a gas distribution system, but shall not consist solely of the delivery of a report or paper. The ideas that were disclosed in papers or reports, however, might be eligible for an award.

If more than one individual worked on a single project considered worthy of nomination for the award, the company shall name the person whom they consider most eligible.

A set of rules, embodying ten points of consideration, has been prepared and is available together with a nominating blank from J. Stanford Setchell, secretary, operating section, AGA, New York 17.

## Gas Sales Declined in May

Sales of the gas utility industry to ultimate consumers during May totaled 3,578 million therms, a decline of 4.1 per cent under sales of 3,730 million therms sold in May, 1951, American Gas Association reports. For the twelve months ended May 31, 1952, gas utility sales were 49,637 million therms, a gain of 9.6 per cent compared with sales of 45,306 therms in the comparable period a year earlier. The AGA index of total gas utility sales for May, 1952, was 316.2 per cent of the average for the years of 1935-1939.

## Employees' Insurance Plan Improved

The group plan of insurance protecting employees of Citizens Gas and Coke Utility, Indianapolis, was revised on July 1 to provide additional protection during times of sickness, accident and hospitalization. The new plan, shown below, is made available to employees without additional cost to them.

Group Sickness, Accident and Hospitalization Insurance

| Benefit | Employee Salaried | Employee Hourly |
|---|---|---|
| **Old Plan** | | |
| Employee, *weekly* | $ 15 | $ 25 |
| Employee and dependent, hosp., *daily* | 6 | 6 |
| Employee and dependent, misc. hosp. charges, *max.* | 60 | 60 |
| Employee and dependent, surg. fee, *max.* | 150 | 150 |
| **New Plan** | | |
| Employee, *weekly** | $ 15 | $ 30 |
| Employee and dependent, hosp., *daily* | 8 | 8 |
| Employee and dependent, misc. hosp. charges, *max.* | 160 | 160 |
| Employee and dependent, surg. fee, *max.* | 200 | 200 |

*Maximum period for weekly benefits has been extended from 13 to 26 weeks.

## Committee Urges Support of Shows

Active participation by gas utilities in local or regional exhibits open to the public such as home building, home furnishing and food shows, and in local or regional exhibits for plumbers, architects or other specialized groups was urged in a report by a special committee on appliance and equipment exhibits, recently approved by the Executive Board of American Gas Association.

The committee believed the biennial exhibit at the AGA Convention should be continued as an exhibit of gas equipment and appliances. It affords manufacturers of equipment an opportunity to display products before the entire gas industry.

It was felt by the committee that exhibits at AGA regional and sectional conferences and meetings should not be encouraged. The policy of conducting exhibits at meetings of state or regional gas associations is to be decided upon by those associations and the manufacturers.

## American-Standard Wins Awards

The *American-Standard Warm Air Heating* catalogue A51 and *Ratings Data and Dimensions*, two publications of American Radiator & Standard Sanitary Corp., won top honors in the 1952 product literature competition co-sponsored by American Institute of Architects and The Producers' Council, Inc.

The only Certificate of Exceptional Merit given in the entire show went to *American-*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THERE IS SAFETY
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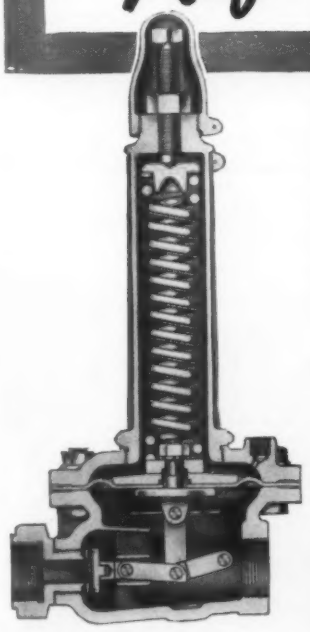
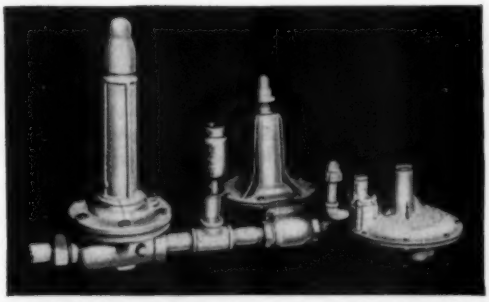


Accurate, Safe Control

of tremendous pressures is an ever present problem in the gas field. Reynolds field Regulator illustrated at left is one of the many high pressure regulators built by Reynolds. It is thoroughly tested and proved in service. It handles up to 1,000 pounds safely reducing same to pounds. For more than fifty-five years Reynolds has designed and built gas regulators. Safety, accurate performance, years of service—these are some of the built-in factors responsible for Reynolds enviable position in the Gas Control Field.



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GAS CONTROL SINCE 1892

*Standard Warm Air Heating.* In addition to full product information, this book presents detailed installation data and sales assistance on a complete line of American-Standard warm air heating equipment.

*Ratings Data and Dimensions* contains statistical information about various types of boilers, radiators, water heaters, conversion burners, baseboard panels and convectors manufactured by American-Standard. Numerous tables and diagrams simplify installation problems.

### Drilling for Gas in Gulf

Texas Eastern Production Corporation is preparing to begin drilling a new offshore well on their lease approximately twenty miles southwest of Galveston and seven and one-half miles off the coast of Galveston Island, in the Gulf of Mexico, H. A. Hemphill, president, announced. The well, projected to a vertical depth of approximately 6,000 feet, will be drilled as a directional hole in an effort to determine more definitely the location and extent of the natural gas reserves underlying the company's 11,070-acre offshore block.

### General Controls in Hartford

General Controls Co. has opened a new office, in Hartford, Conn., to serve the New England trading area. Joe Crandley, formerly manager of the firm's Baltimore office, has been named district manager of the new Hartford branch, at 410 Asylum St.


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Steps up gas-making efficiency . . . improves quality . . . saves fuel, manpower!

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### William N. Grinstead

William N. Grinstead, president, The Ohio Fuel Gas Company, died August 2 at Asheville, N. C., after becoming ill while on vacation at Chimney Rock, N. C. He was 52 years old.

Wm. N. Grinstead

Mr. Grinstead joined Columbia Engineering Corporation (now Columbia Gas System Service Corporation) in Pittsburgh in 1929 after spending eight years with the Appalachian Electric Power Company and the Mountain Service Corporation. In 1930 he was transferred to Binghamton, N. Y., as treasurer of the Binghamton group, Columbia Gas System.

He was elected treasurer and a director of The Ohio Fuel Gas Company, Columbia's Columbus group, in 1939 and in 1947 he was elected vice president of the company. Three years later he became general manager and was elected president in May, 1951.

A native of Marion, Va., Mr. Grinstead attended Milligan College, Milligan, Tenn. He was a member of the American Gas Association's committee of executives on taxation. Surviving him are his wife, four sons and one daughter.

### Gas Sales Higher in June

Sales of gas to ultimate customers in June, 1952, totaled 3,271 million therms, a gain of 0.4 per cent over 3,257 million therms sold in June 1951, American Gas Association reports. The AGA index of total gas utility sales for June, 1952, was 312.1 per cent of the average for five-year period at 1935-1939.

### Sprague Names Two Representatives

The Sprague Meter Company has appointed two new field representatives, W. A. Hill, Jr., of Atlanta, to cover the Southeast-

W. A. Hill, Jr.

Ray Fogelman

ern territory of Virginia, North and South Carolina, Georgia, Alabama, Florida and Cuba; and Ray Fogelman for the states of Texas, Louisiana and Mississippi, with headquarters in Houston.

## MEN AT WORK

### SoCounties Adds Financial Analyst

Dr. Cecil L. Dunn, former chairman of the department of economics, Occidental College, Los Angeles, has joined Southern Counties Gas Co., as a financial analyst.

### A. B. Fisher Named Koppers VP

A. B. Fisher, Jr., Koppers Company, Inc., has been appointed a vice president in the company's engineering and construction division and will serve as executive assistant to the general manager and assistant general manager of the division.

### Michigan Association Elects Officers

Michigan Gas Association elected these new officers on June 24: president, Wallace M. Chamberlain, Michigan Consolidated Gas Co.; vice president, Elmer V. Gmeiner, Citizens Gas Fuel Co., Adrian; secretary-treasurer, Albert G. Schroeder, Michigan Consolidated Gas Co.

### Stebler is ExecVP, GAT Corp

W. J. Stebler was elected executive vice president of General American Transportation Corporation, manufacturers of the Wiggins Gasholder, at the meeting of the company's board of directors in late July.

WILLIAM ANDERSON was named secretary, *Manufacturers Light and Heat Co.*

JAMES H. BINGER was elected vice president, *Minneapolis-Honeywell Regulator Co.*

FRANK V. DOUCETTE has been promoted to assistant to the president, *Southern Counties Gas Co.*

GEORGE DOULAMES is now superintendent of operation center and assistant to the engineer, *Lowell (Mass.) Gas Co.*

ROBERT B. DUGGAN is now chief engineer, coal and oil department. *American Radiator & Standard Sanitary Corp.*

DAN J. EGAN has been advanced to assistant vice president, *Manufacturers Light and Heat Co.*

F. EUGENE ENGLANDER has been appointed sales manager, Richmond division, *Gar Wood Industries, Inc.*

REX FALKNER joins the sales staff of *William Wallace Co.*

W. A. FINN has been promoted to assistant general sales manager, *Worthington Corp.*

LEO J. KENNEDY has been appointed engineer, *Lowell (Mass.) Gas Co.*

KENNETH E. KOCH is now new construction manager in the sales department of *Lowell (Mass.) Gas Co.*

KURT KRAFFT was promoted to manager, heating division, research department, *American Radiator & Standard Sanitary Corp.*

JOHN E. OVERBECK was elected assistant vice president, *Columbia Gas System Service Corp.*

F. E. POLTIER is now manager of engineering and service in Cleveland for *Worthington Corp.*

JOHN J. REDMON has been appointed manager of the product service branch in Dallas by *A. O. Smith Corp.*

RUTH I. RITCHEY has been appointed home economist by *Ohio Gas Company.*

RUSSELL STRONGMAN has been transferred to manager, New York branch, *General Controls Co.*

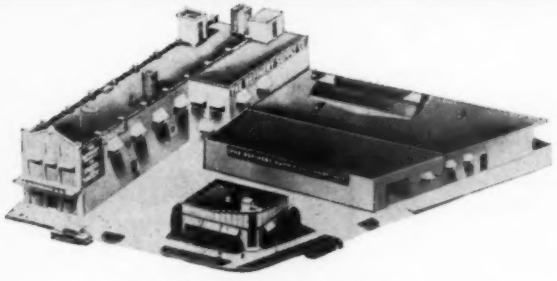
RALPH M. WATSON is now director of research, *Worthington Corp.*

HARRY WISEMAN, as sales promotion manager, has joined *Southern Heater Co.*

M. E. ZIEGENHAGEN is the new advertising and sales promotion manager of *Worthington Corp.*

### Industrial piping information

PIPING FOR NATURAL AND MANUFACTURED GAS—Industrial Installations. Standards which are designed to provide safe piping arrangements are set forth clearly in this bulletin which merits the attention of all who are concerned with gas pipe arrangement in industrial installations. The selection, location, valving, testing and operation of new piping are described concisely. For outdoor piping, suggestions are made to prevent corrosion and sealing around wall openings. The indoor piping suggestions include location, ventilation, support and corrosion protection. The bulletin continues with appropriate suggestions for existing piping, meters, pressure regulators and gas holders. Bulletin 11.88. 12 pp. Associated Factory Mutual Fire Insurance Cos., 184 High St., Boston 10.

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R. S. Orifice Well Tester
R. S. Moisture Tester

R. S. Flat Bore Yel-O-Bak Thermometers
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# Properties of Natural Gas Odorants

*(Continued from page 15)*

room and the weight of soil can be found for each soil using the second equation, above. Using this relationship, curves were plotted, along which the natural gas in a room would be at its lower explosive limit at the same time that the first odor could be detected, as shown in figure 5.

It will be noted that the probability of attaining an explosive mixture, before detection by odor, increases when gas passes through sand, caliche, weathered limestone, cinders, and black soil respectively. It should be pointed out that the above is for an air-tight room and that under normal conditions of varying number of air changes per hour the explosion tendency would decrease.

## Conclusion

From tests conducted, it appears that, with the exception of cinders, when odorized natural gas passes through the various soils tested, adsorption is the primary method by which the odorant is removed. The primary ability for a soil to remove an odorant increases with its surface area or colloid content, although water content, temperature, and oxidizing materials are other variables, the latter more so in the case of cinders.

## References

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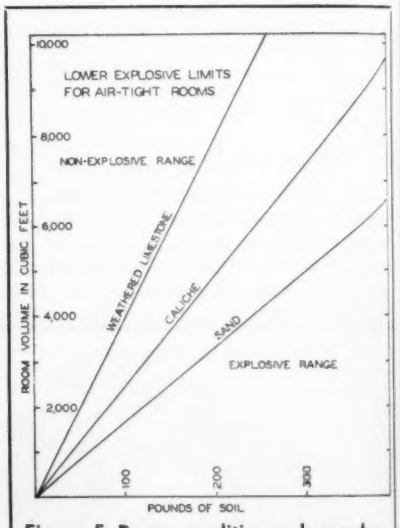


**Figure 5. Room conditions when odorized natural gas passes through soils**

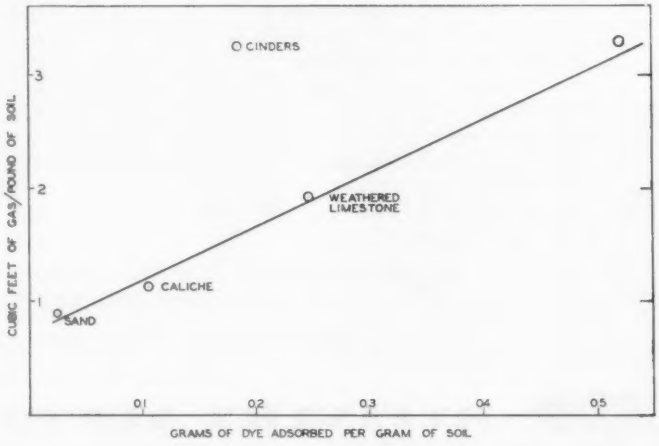


**Figure 4. Dye adsorbed per gram of soil vs. cubic feet of gas per pound of soil**

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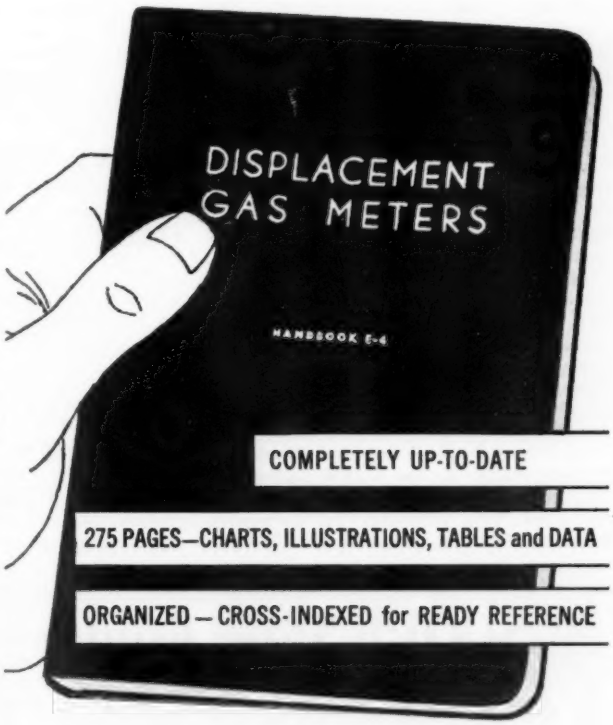


COMPLETELY UP-TO-DATE

275 PAGES—CHARTS, ILLUSTRATIONS, TABLES and DATA

ORGANIZED—CROSS-INDEXED for READY REFERENCE

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GAS METERS
PHYSICAL PROPERTIES OF GASES
THE TINNED STEELCASE METER
THE IRONCASE METER
CAPACITIES OF METERS
THE MEASUREMENT OF GASES AT HIGH PRESSURE AND VACUUM
THE METER PROVER
TESTING METERS FOR PROOF
TESTING HIGH-PRESSURE METERS
PRINCIPLES OF METER MAINTENANCE
LEAK TESTS AND APPARATUS
FITTING ADJUSTMENT
STANDARD REPAIR PROCEDURES
REPAIRING TINNED STEELCASE METERS
REPAIRING IRONCASE METERS
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As a special service to the Gas Industry, the American Meter Company offers the most authoritative guide ever published on operation, tests, maintenance and repair of Ironcase and Tinned Steelcase Meters—The New E-4 Handbook of Displacement Gas Meters, edited by John C. Diehl.

The new comprehensive manuals are available at the special pre-publication price of $3.00 per copy until November 1. After this date, limited reprinting will necessitate a price of $4.50 per copy.

For your copy, write Publication Department, American Meter Company, 920 Payne Ave., Erie, Pa.

**AMERICAN METER COMPANY**
INCORPORATED ESTABLISHED 1836

## NEW EQUIPMENT

### Rigid plastic pipe, compression fittings

The development and production of an improved rigid plastic pipe and of a new design of compression-type coupling have been announced. The manufacturer states that these products have increased resistance to burst, high tensile and flexural strengths, greater chemical resistance and the ability to withstand sunlight. They maintain features of light weight, ease of handling, resistance to deteriorents. The pipe is supplied in 10- and 20-foot random lengths which can be connected by the new type of coupling or by slip-sleeve tees and ells. The feature described for the new fitting is that longitudinal force exerted on a rubber gasket incorporated into the fitting creates a secondary force at right angles to maintain a leakproof joint. Also, the new coupling is said to compensate for expansion and contraction of the rigid pipe. The pipe is available in standard sizes from ½" to 2" and threaded adapters are available for connection of the plastic pipe to metallic pipe.

*Carlon Plastic Pipe and Compression Coupling.* Carlon Products Corp., 10025 Meech Ave., Cleveland 5.

### Threadless pipe connector

No thread cutting is required, the manufacturer states, to use a new factory-assembled pipe coupling in which pipes are connected with couplings by tightening lock nuts. Working pressures to 2,000 psi are claimed for this coupling which is made of pipe steel and cold rolled steel using a compression rubber gasket. Applications to gas systems are recommended by the manufacturer. The coupling is available in from ½" to 1½" ips.

*Quik-Joint.* Quik-Joint Manufacturing Co., Harvey, Ill.

### Pneumatic pressure regulator

A new series of pneumatic pressure regulators intended for close regulation in industrial applications has been developed. The series is designed to reduce line pressures as high as 150 psi to required lower working pressures. They are available for ⅛", ¼" and ⅜" pipe sizes, with or without filters and with pressure relief.

*V-301 and V-302.* General Controls Co., Los Angeles.

### Metallic joint sealing compound

The manufacturer of a new sealing compound claims easier removal of clean-out plugs and that it serves as an anti-seize coating. It is described as a pure metallic lead pipe thread lubricant and sealer which is free of drying agents and is claimed to be impervious to air, water, steam, oils, ammonia and hydro-carbons. The temperature range is from —100 to 2,987°F.

*Compound 411.* Armite Laboratories, 6609 Broad St., Los Angeles 1.

### Heat resistant paint

A new ready-mixed aluminum paint has been made available for application to metallic surfaces as a protective finish for furnaces, pipes, boilers and ovens, withstanding temperatures to 1600°F. The manufacturer claims that the heating action serves to create a bonding effect. The paint is anti-corrosive and weather-resistant. It may be brushed, sprayed or dipped and dries within thirty minutes.

*Super-Hot.* Sheffield Bronze Paint Corp., 17814 Waterloo Rd., Cleveland 19.

### Public utility truck bodies

Two new truck bodies have been designed for public utility use. The compartments are equipped with shelves, trays, material hooks and parts bins. Also included is an overhead rack with adjustable brackets. The doors are of weathertight construction, with flush-mounted, slam-action handles and cylinder locks. Optional equipment includes telescopic roof, hinged ladder rack, side-mounted ladder rack, rear bumper-step and other accessories. Lengths of bodies in series 44, without superstructures, are 75", 90" and 104"; in series 44-L the lengths are 90" and 104".

*Series 44 and 44-L Utility Bodies.* McCabe-Powers Auto Body Company, St. Louis 15.

### Flexible plastic pipe

Flexible plastic pipe intended for use as gas service lines in new or replacement work has been announced, with the manufacturer's guarantee against rot, rust and corrosion. Also, it is impervious to chemical actions, alkalies, sulphur and metallic salts. The manufacturer points to the ability of the pipe to absorb vibration stresses.

*(Continued on page 39)*


**M-SCOPE Pipe Finder**

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## NEW BULLETINS

REFRAK SCREEN BURNERS. This new bulletin describes a special design of a tunnel-type multiport gas burner that can be used in either furnace or open-firing applications. These burners are designed to operate with pressurized mixtures of any fuel gas and air. The design provides for operation on either low or high gas-air mixture pressures. Burners of this design deliver from 2,000 to 6,000,000 Btu per hour.

*Bulletin SC-1009.* 8 pp. Selas Corporation of America, Philadelphia 34.

THERMOCOUPLES. This is a completely descriptive bulletin pertaining to thermocouples and their accessories, parts and assemblies with appropriate information pertaining to sizes, applications by industry, temperature and accuracy limits. The catalog is indexed for easy reference and is fully illustrated.

*Catalog EN-S2.* 46 pp. Leeds & Northrup Co., Philadelphia 44.

ELECTRIC CONTROL THERMOMETERS. The electric control thermometers described in this bulletin are available as either indicators or recorders and are of the pressure-type, equipped with a bulb and capillary tubing system. The thermal system may be actuated by either vapor or gas. The instruments are intended for such industrial operations as paint drying ovens, cooking kettles, lumber kilns and plating tanks. The bulletin is completely descriptive and admirably illustrated to show the action of the instrument. A number of charts and scale ranges are offered and listed in detail. Complete selection information is given together with ordering information.

*Catalog 6482.* 10 pp. Station 40, Minneapolis-Honeywell Regulator Company, Philadelphia 44.

IBM ACCOUNTING. This booklet was prepared for utility companies and describes the manufacturer's method of customer accounting. Generally the system described in considerable detail and fully illustrated is the same as the one that was featured in AMERICAN GAS JOURNAL, February, 1952.

*Bulletin 52-3796-2.* 40 pp. International Business Machines Corp., 590 Madison Ave., New York 22.

INDUSTRIAL COMBUSTION EQUIPMENT. A wide range of industrial combustion equipment using gas or oil as fuel is presented in this new bulletin. The equipment is designed for production, construction and maintenance applications.

*Catalog 52.* 12 pp. Hauck Manufacturing Co., Brooklyn 15, N. Y.

AUTOMATIC CONTROL SYSTEMS. This bulletin describes a line of pressure regulators in sizes from 2" to 12" and for operation where inlet pressures up to 600 psi are to be reduced to from two to 500 psi. A separate line of extra-high pressure regulators for inlet pressures up to 1,200 psi is also described. A series of automatic controls systems described in this bulletin can be used to adapt the manufacturer's "015" regulators to a variety of pressure conditions and requirements. These regulators are designed for service with manufactured, natural and LP gases. The bulletin is fully descriptive of the operations of the regulator and includes easy-to-understand sectional drawings, in color, together with pertinent selection data in terms of pressures and sizes, complete body dimensions and photographs.

*Bulletin 1086.* 16 pp. Rockwell Manufacturing Co., Pittsburgh 8.

DITCH BRIDGE. Designed for the information of utility companies, this bulletin describes a bridge for crossing utility ditches with trucks and other right-of-way equipment. The manufacturer notes that a bridge will sustain a 16,000 pound rear axle load over a ditch. Each bridge, one for each wheel, has a wheel guide. The bridges are relatively light, made of magnesium.

*Bulletin DB1-452.* 4 pp. Magnesium Products of Milwaukee, 748 W. Virginia St., Milwaukee 4.

P-R GAS BURNERS. Multiport flame type gas burners are the subject of this new bulletin. The burners are used in heat processing such as high temperature alloy brazing; glass fire polishing; heating solder pots, core ovens and die molds; soldering; baking; tempering and hardening. The burners can be used with any commercial fuel gas and in any air-gas mixing system that develops the required mixture pressure. Capacities and specifications are given with appropriate dimensional drawings.

*Bulletin SC-1000.* 4 pp. Selas Corporation of America, Philadelphia 34.

GAS BURNER NOZZLES. The burner nozzles that are the subject of this bulletin are intended for blast firing of air-gas mixtures into open ports of furnaces or for firing in the open. The manufacturer claims they are also useful in kiln firing, heat treating, melting, ovens, air heaters, boilers, kettles and immersion tubes. The bulletin includes the data on the capacities and dimensions of the two types, straight and elbow, that are manufactured.

*Catalog 804C.* 4 pp. Hauck Manufacturing Co., 124 10th St., Brooklyn 15, N. Y.

CASE HARDENING. Furnaces for case hardening are presented in a new bulletin with description of applications to gas carburizing, liquid carburizing and cyaniding and pack carburizing. Two lines of furnaces of the muffle type are presented together with a controlled atmosphere generator for them. Also described are the manufacturer's direct-fired oven furnaces.

*Bulletin SC-159.* 4 pp. Surface Combustion Corp., Toledo 1, Ohio.

THERMOCOUPLES, RADIATION DETECTORS, RESISTANCE BULBS. A new data book and catalog, showing the applications, recommendations and selection information for instrument sensing units and associated accessories, has been issued for the use of those concerned with control of combustion processes. In addition to the catalog information about a wide range of equipment, this book contains a great deal of pertinent data.

*Bulletin TC-9.* 42 pp. Barber-Colman Co., Rockford, Ill.

PRESSURE GAUGES WITH CONTROLS. Three new specification sheets covering recording type pressure gauges and coordinated controls have been issued. Generally, these are applicable to precise industrial processes.

*Specification Sheets 708, 709, 710.* 4 pp. Station 40, Minneapolis Honeywell Regulator Co., Philadelphia 44.

LIQUI-JECTORS. Two revised bulletins pertaining to equipment for the removal of water, water-oil emulsions and dirt from compressed air and gas lines have just been released. The equipment operates without moving parts, using specially treated ceramic filter candles to clean the air or other gas without significant pressure drop. One series of the equipment covers the range of 10-to-75 cfm; the second series, from 100-to-500 cfm. Liquids are ejected continuously and automatically, the filter candles are readily removed for cleaning.

*Bulletin SC-1007-1008.* 6 pp. Selas Corporation of America, Philadelphia 34.

AUTOMATIC FIRE CHECKS AND SAFETY BLOWOUTS. A new bulletin describes fully two protective devices used in the piping systems of gas-and-air combustion systems. The automatic fire check is used to detect, localize and extinguish a flashback in the gas-air mixture lines, close to the gas burners. The safety blowout is used to prevent damaging flashbacks in the main supply piping from damaging combustion control equipment and to relieve excessive flashback pressures by diverting the shock forces safely.

*Bulletin SC-1006.* 12 pp. Selas Corporation of America, Philadelphia 34, Pennsylvania.


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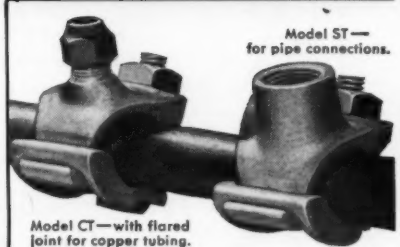
FOR REFRIGERATORS, LAUNDRIES, WATER-HEATERS, ETC.

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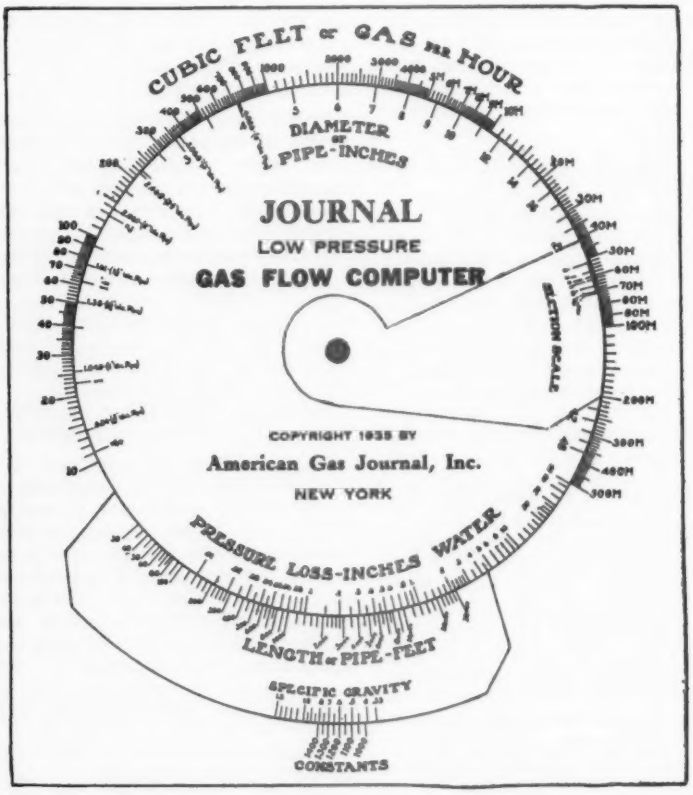


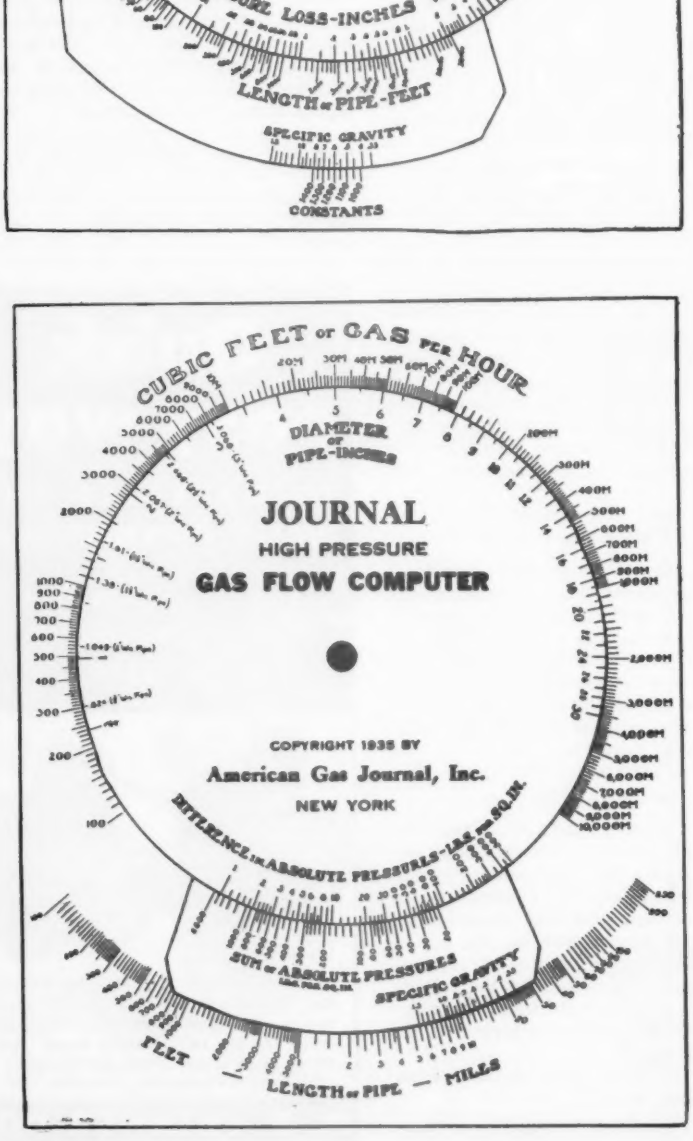


# JOURNAL

## Gas Flow

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Pipe diameters . . . . . ¾" to 48"
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Pipe length (feet) . . . 30 to 30,000
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Pipe length (miles) . . . . . 1 to 250
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The computers are printed on heavy durable plastic, enclosed in leatherette cases with complete instructions for their use.

*PUBLISHED AND SOLD ONLY BY:*

AMERICAN Gas Journal

205 E. 42nd Street,
New York 17, N. Y.

## NEW EQUIPMENT

*(Continued from page 36)*

Flexibility permits following irregular ditch contours and eliminates multiple use of fittings.

*Carlon Flexible Plastic Pipe.* Carlon Products Corp., 10225 Meech Avenue, Cleveland 5.

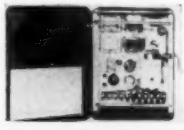
### Hydraulic dump truck body hoist

A complete new line of hydraulic dump truck body hoists featuring design improvements has just been announced. Fourteen models of this new hoist are available in a selection of capacities from 6 to 25 tons. The new body hoists are said to feature the lowest standard mounting height; also advanced lifting point, new low operating oil pressures, a new flexible subframe, friction-free roller bearing drive mechanism, including pump and power takeoff. A unique stress-eliminating design feature of the new hoists is claimed to almost entirely absorb dumping shocks and permits use of a new hoist principle.

*St. Paul Hoist.* Customer Service Dept., St. Paul Hydraulic Hoist, Wayne, Mich.

### Gas burner programming control

This device is designed to provide automatic starting and programming control for commercial and industrial gas and combination gas-oil burner equipment. The control automatically starts a burner in operation and programs a sequence of pre-purge, ignition-on, fuel valve delay, post-ignition timing and post-purge. It is claimed to have instantaneous response to flame failure, with complete fuel cut-off in two to four seconds, providing protection from explosion hazards. A built-in time delay prevents false shutdown from transient effects such as smoky streaks in the flame or irregular draft conditions. Cam assembly construction permits programming variations. The control is designed to provide continuous operation on industrial installations and is labeled by Underwriters' Laboratories Inc., and Factory Mutual Laboratories.



*Fireye Programming Control Type 26RJ8.* Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.

### Magnetic gas valve

A new 3½ pound capacity magnetic gas valve designed for pilot line service on high pressure burner installations has been added to this manufacturer's established line. The new valve is available for 115 or 230 volt service in ¼" and ⅜" sizes. A hammer-action plunger and a stainless steel seat cast into the valve body are pointed out as features.

*V495 Magnetic Gas Valve.* Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

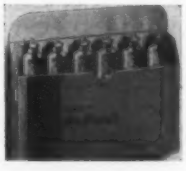
### Fittings for flexible plastic pipe

A new line of insert-type ell and tee couplings has been made available for use with flexible plastic pipe to facilitate making sharp turns or take-offs. The fittings are joined to the pipe by forcing the flexible tubing over the serrated ends of the fittings and then are sealed by tightening stainless steel clamps over the joint. The manufacturer claims that only a saw and screwdriver are necessary to make the connection in less than two minutes. An insert adapter is available for joining plastic pipe to metallic pipe, using threads at the metallic end and clamps on the plastic end. All fittings are of molded thermoplastic.

*Carlon Fittings for Flexible Plastic Pipe.* Carlon Products Corp., 10025 Meech Ave., Cleveland 5.

### Insect repellent

Utility and pipeline company field employees are said to be among those who can avoid the discomfort and the distractions caused by mosquitoes, flies and other insects, through applications of a repellent that is now available as a first aid item. Among the features reported for the repellent is the lasting quality. A small amount of the cream rubbed on the hands, neck and face is said to keep mosquitoes, flies, ticks, chiggers and other insects away for hours. As reported by the company, it has a pleasant aroma, is not sticky, will not stain or harm clothing.



*Pellent.* Medical Supply Co., Rockford, Ill.

### Oil and gas field display kit

A simplified kit for a model oil and gas field, showing details of exploration, drilling, production and storage, has been made available. The kit, designed originally for school use is said to be technically accurate and designed to scale. It was developed by Standard Oil Company of California, who granted manufacturing and distribution rights for display purposes. The kits contain essential elements of a producing field. There are large drawings of underground strata. The kit includes a 32-page illustrated handbook, which enable any adult to assemble or to give necessary instruction for assembling the models. Since their introduction by Standard of California, the kits are said to have been well received because they depict graphically the field portion of the industry, including the conservation of oil and gas.

*Model Oil Field Display.* Dept. A., Models of Industry, Inc., 2804 Tenth St., Berkeley 2, Cal. $3.95, postpaid in U.S.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## GAS INDUSTRY CALENDAR

### September

7-9 Wisconsin Utilities Assn. management conference, King's Gateway Hotel, Land O'Lakes, Wis.
11-12 Mid-West Gas Assn., school and conference, Iowa State College, Ames, Ia.
12 New Jersey Gas Assn., annual meeting, Atlantic City.

### October

1-3 Wisconsin Utilities Assn., technical and sales convention, Schroeder Hotel, Milwaukee.
7-9 Pacific Coast restaurant convention and exposition, Biltmore Hotel, Los Angeles.
20-24 National Metals Exposition, Philadelphia.
27-30 AGA annual convention, Atlantic City.
27-31 GAMA exposition, Atlantic City.
28 AGA executive board, Atlantic City.
30 LPGA northeastern annual meeting, Ambassador Hotel, Atlantic City.

### November

20-21 Mid-Southeastern Gas Assn., Sir Walter Hotel, Raleigh, N. C.
20-22 South. California Meter Assoc., instrument maintenance course, Los Angeles Harbor Jr. College

### March, 1953

26-27 NEGA, Hotel Statler, Boston.
27-29 Mid-West regional gas sales conference, Edgewater Beach Hotel, Chicago.
30-Apr. 1 Mid-West Gas Assn., Broadmoor Hotel, Colorado Springs, Colo.

### April, 1953

12-16 AGA distribution, motor vehicles and corrosion conference, Hotel Sherman, Chicago.
21-23 Southwestern measurement course, University of Oklahoma, Norman.

### May, 1953

3-8 LPGA convention and show, Conrad Hilton Hotel, Chicago.


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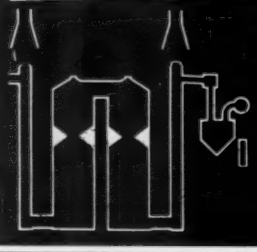

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